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Use of Ground Penetrating Radar for Locating Contraband Aboard Ocean Going Vessels: Feasibility Study

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Use of Ground Penetrating Radar for Locating Contraband Aboard Ocean Going Vessels: Feasibility Study

by José L. Llopis, Janet Simms

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Final report

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Prepared for U.S. Coast Guard Research and Development Center
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Preface

Personnel of the U.S. Army Engineer Research and Development Center (ERDC) conducted a series of ground penetrating radar (GPR) surveys at the Alabama State Docks, Mobile, Alabama, during the period 20-22 September 2000. The work was funded by the U.S. Coast Guard Research and Development Center (R&DC), Groton, CT, under MIPR DTCG39-00-X-R00012, dated 13 April 2000.

The GPR surveys were conducted by Mr. José L. Llopis and Dr. Janet E. Simms, Engineering Geology and Geophysics Branch (EGGB), Geosciences and Structures Division (GSD), Geotechnical and Structures Laboratory (GSL), ERDC. Dr. Chih-Wu Su, U.S Coast Guard R&DC, and Mr. Steve Rigdon, Anteon Corporation, Groton, CT, were project managers.

The work was performed under the direct supervision of Dr. Lillian D. Wakeley, Chief, EGGB, and under the general supervision of Drs. Robert L. Hall, Chief, GSD, and Michael J. O'Connor, Director, GSL.

At the time of publication of this report, Dr. James R. Houston was Director of ERDC, and COL John W. Morris III, EN, was Commander and Executive Director.

Executive Summary

In January 2000 personnel of the U.S. Coast Guard Research and Development Center (R&DC), Groton, CT, and the U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS, met to discuss possible methods to non-intrusively locate contraband aboard ocean going vessels. R&DC personnel were particularly interested in using current or developing technologies that could be used for this purpose. R&DC personnel stipulated that the equipment had to be compact, man-portable, be able to be used in confined areas of ships, be user-friendly, and the results easy to interpret. One of the methods that was agreed to show promise in locating contraband in the holds of ships was ground penetrating radar (GPR).

GPR surveys were conducted over various stockpiled materials at the Alabama State Docks located in Mobile, AL, to determine whether GPR is a viable method for rapidly detecting contraband materials buried in the cargo holds of ocean going vessels. The surveys were conducted by burying various objects including a contraband simulant (a bundle of four 10-lb bags of sugar duct-taped together) in stockpiled materials available at the site. The stockpiled materials tested were crystal gypsum, powdered gypsum, crushed pumice, coarse coal, fine coal, and bauxite.

Two GPR systems, the pulseEKKO 1000 and the Noggin Plus systems, manufactured by Sensors & Software, Inc., were used to conduct the surveys. Antenna frequencies ranged between 225 and 900 MHz. GPR surveys were run over the stockpiled materials using a suite of antenna frequencies to determine the effects of material type on depth of penetration and target resolution.

All of the antennas tested were successful in detecting the location of the contraband simulant in at least one of the stockpiled materials. The 225 and 250 MHz antennas had the highest percentage of detecting the simulant in the stockpiled materials (60 and 90 percent, respectively) whereas the 900 MHz antenna had the lowest (30 percent). All of the antennas tested have penetration depths of greater than 1.5 m.

The GPR surveys run on the different stockpiled materials at the Alabama State Docks demonstrate that GPR is a feasible means of locating contraband buried to depths of at least 1 to 2 m (limit of testing). However, the probability of success of locating contraband with GPR on board ships depends on the size and

depth of the target as well as the magnetic and electrical properties of target and the material in which it is hidden.

Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
feet	0.3048	meters
inches	2.54	centimeters
ohm-feet	0.3048	millisiemens per meter
pounds (force)	4.44822	newtons

1 Introduction

Background

A series of ground penetrating radar (GPR) surveys were conducted in Mobile, AL, during the period 20-22 September 2000 in support of the U.S. Coast Guard Research and Development Center's (R&DC), Vessel Search Project. Personnel of the Geotechnical and Structures Laboratory (GSL), Engineer Research and Development Center (ERDC), Vicksburg, MS, conducted the GPR surveys. The purpose of the surveys was to determine the effectiveness of GPR in locating contraband buried in various types of bulk cargo materials.

Ground Penetrating Radar Principles and Equipment

Traditionally, GPR has been used as a geophysical technique for subsurface exploration. GPR involves transmitting high-frequency electromagnetic (EM) pulses into a material. The GPR system consists of a transmitting and receiving antenna. When the transmitted EM signal impinges upon the boundaries of materials with contrasting electrical properties some of the EM signal is reflected back to the surface where it is detected by the receiving antenna. The time the signal takes to travel from the transmitting antenna, reflect off a boundary, and be detected by the receiving antenna are amplified, processed, and recorded to provide a "continuous" profile of the subsurface, as illustrated in Figure 1. The lack of coincidence between zero time and zero depth is due to the separation of the transmitter and receiver antenna. The first arrival at tile receiver is the direct wave traveling from the transmitter to the receiver, not the reflection from the ground surface. The time span between zero time and zero depth is the one-way travel time of the direct wave between the transmitter and the receiver. The depth scale, in particular at very shallow depths, is nonlinear. The depth scale is based on the velocity of the transmitted EM pulse through the propagating media. Because the transmitter and receiver antenna are separated by a finite distance and the transmitted pulse has a lobe-shaped radiation pattern, the ray of the transmitted pulse that arrives at the receiver does not strike the subsurface interface at normal incidence, but at an acute angle. The depth scale is corrected for non-normal incidence of the transmitted ray path.

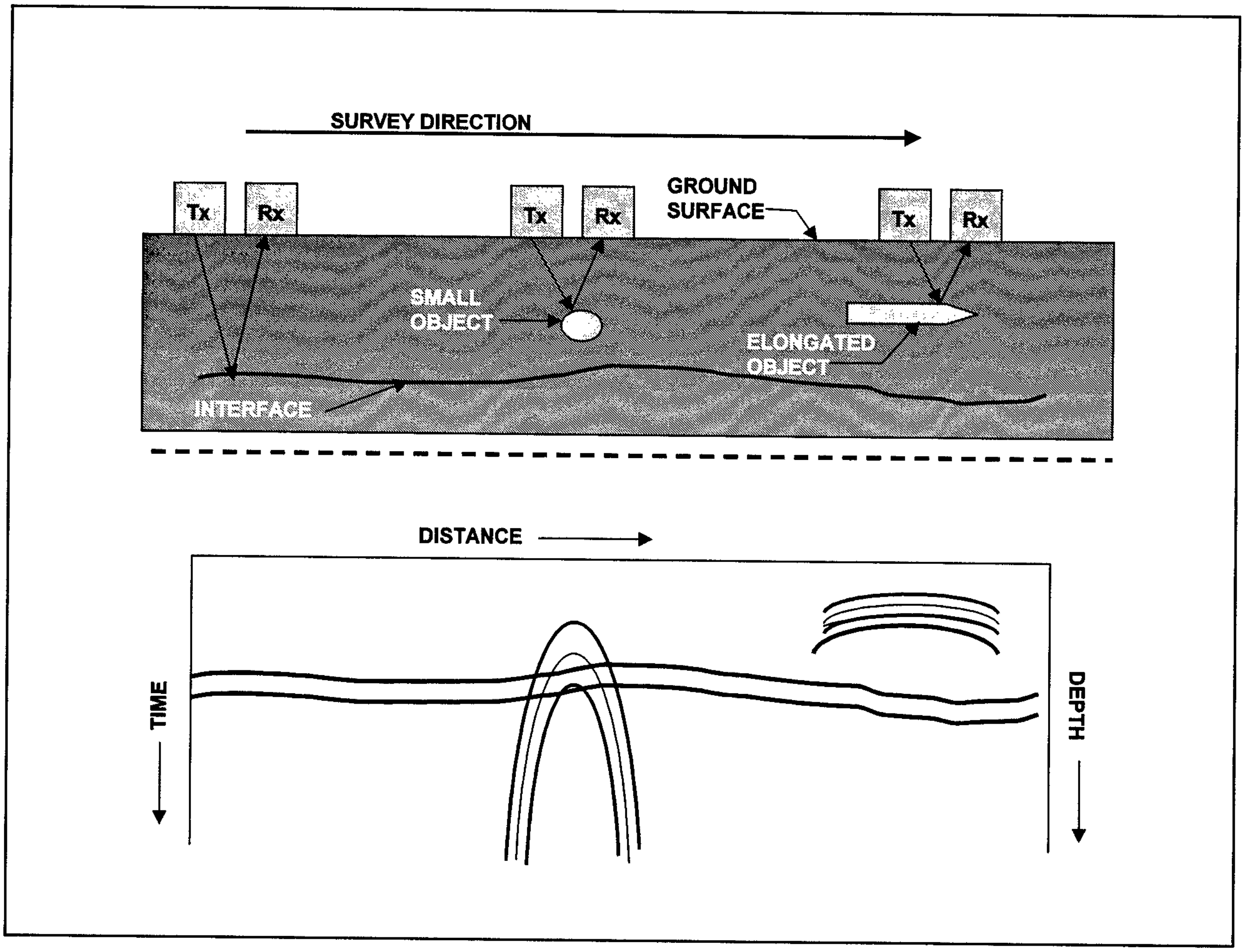

Figure 1. GPR concepts

The transmitted EM signals respond to changes in materials with sufficiently different electrical properties such as those caused by mineral content, salinity, water content, density, voids, etc. The depth of penetration and amount of definition that can be expected is determined by the electrical properties of the host material being tested as well as the power and frequency of the transmitting antenna. In general, the higher the conductivity of the host material is, the less the GPR depth of penetration. The primary disadvantage of GPR is its extremely site specific applicability. It is difficult to predict whether GPR will be successful in accomplishing its goal without prior knowledge of the electrical properties of the host materials.

Two Sensors and Software, Inc. GPR systems were used for these tests: a pulseEKKO (pE) 1000 and a Noggin Plus. Antenna frequencies of 225, 450, and 900 MHz were used with the pE 1000 while a 250 MHz antenna was used with the Noggin Plus system. The reflection profiling survey mode was used for these surveys. In this mode, the receiving and transmitting antennas are kept a fixed distance apart as the antenna pair is pulled along a survey line. Antenna separations of 0.5, 0.25, and 0.170 m were used with the 225, 450, and 900 MHz antennas, respectively. Although the pE 1000 system allows the flexibility to vary

the antenna separation, the antenna separations used in this study are those typically used in subsurface investigations. The antenna separation for the Noggin Plus 250 MHz antenna is a fixed 0.35 m.

As previously mentioned two different GPR systems were used, the pE 1000 and the Noggin Plus. Fundamentally, the two systems are alike however there are several operational differences. The pE 1000 system is a very flexible instrument in that it allows different antenna separations and orientations, modes of operations, and system parameters to be used. System parameters are input and controlled from a laptop computer. As the data is being collected a profile of the subsurface is displayed on the laptop's screen. Because of its flexibility it takes an experienced operator to use the system effectively. Figure 2 shows the pE 1000 system with the 225 MHz antennas. On the other hand, the cart mounted Noggin Plus is a more user-friendly and straightforward system to operate. The system consists of an antenna and a digital video logger (DVL) all mounted on a cart (Figure 3). Once the unit is unfolded and powered-up, a GPR survey can begin in less than a minute. The DVL is used to input system parameters, collect, display, and store data.

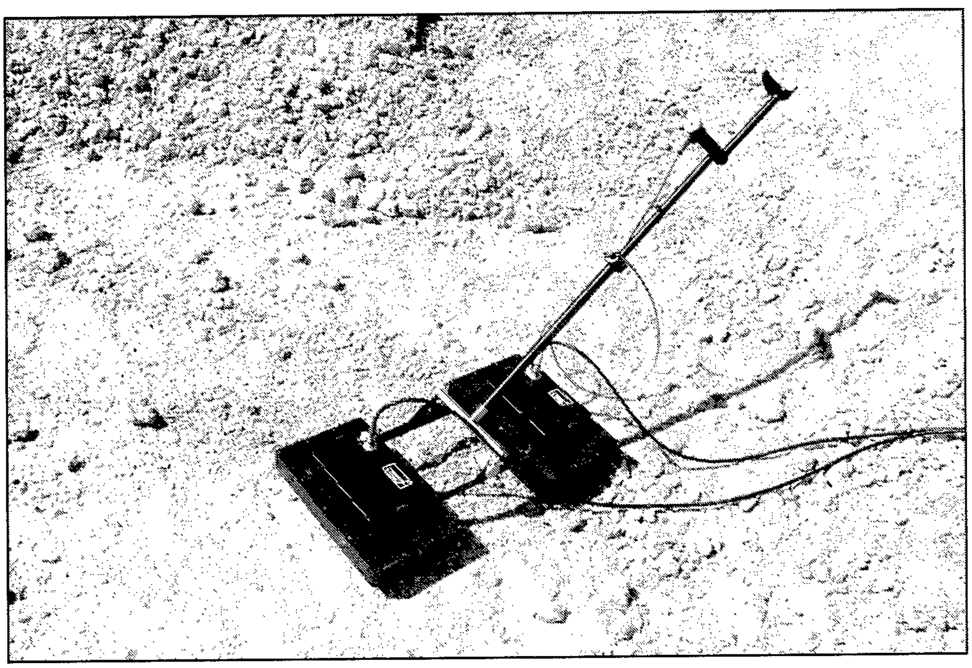

Figure 2. Sensors and Software pE 1000 GPR system with 225 MHz antennas

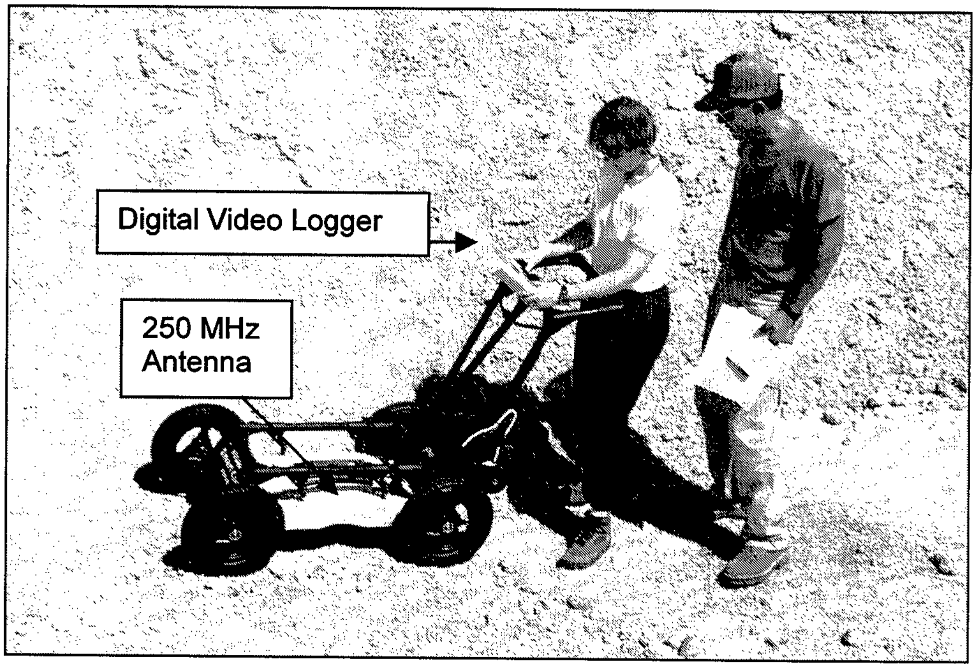

Figure 3. Sensors and Software Noggin Plus Smart Cart system with 250 MHz antenna

2 GPR Field Tests

The GPR surveys were conducted over several different stockpiled materials at the Alabama State Docks, Mobile, AL, and that are typical of cargo carried in the holds of ocean going vessels. Stockpiled materials available at the time of testing were gypsum (crystal form), finely powdered gypsum, crushed pumice, coal, and bauxite.

Initial Investigations

The objective of the first phase of testing day was to determine the penetrating capabilities of the different antennas in selected stockpiled materials. This was accomplished by burying an object that would reflect EM signals back to the ground surface, in this case a steel pipe 5.1 cm in diameter and 30.5 cm long, in the stockpiles of crystal and powdered gypsum, pumice, and coal. The depths at which the pipe was buried varied between approximately 15 and 32 cm. The surveys were typically conducted by dragging a given radar antenna set on the ground surface along profile lines that were perpendicular to the long axis of the steel pipe. The profile lines were extended beyond the pipe by one or more meters to allow the collection of undisturbed (background) information. Survey lines were run directly over and in some cases off to one or both sides of the pipe. The steel pipe is identifiable in the record as vertically alternating dark and light bands in the shape of a hyperbola as shown in Figure 4.

Crystal gypsum pile

Figure 5 shows the crystal gypsum pile being prepared for a GPR survey. The material is coarse-grained and has little or no fine-grained material as shown in Figure 6. The steel pipe was laid on the ground surface oriented in a north-south orientation and covered to a depth of approximately 15 cm with gypsum crystals. A sketch of the test layout showing the orientation of the four survey lines relative to the steel pipe is presented is shown in Figure 7. The GPR records of the surveys conducted over the crystal gypsum pile are presented in Appendix A. Table 1 presents the GPR results for the pE1000 and Noggin systems. The pipe was detected with the pE 225 and 450 MHz antennas and with the Noggin system. The depth of penetration in this material is approximately 1 to 1.5 m and is based on the strength of the GPR signal returns seen on the records.

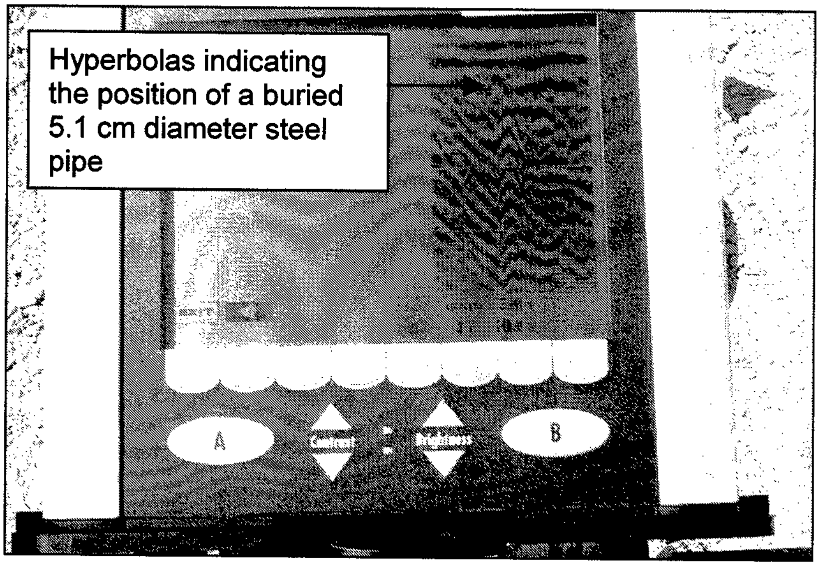

Figure 4. Hyperbolic signature of a 5.1 cm diameter steel pipe buried approximately 15 cm in stockpiled crystal gypsum

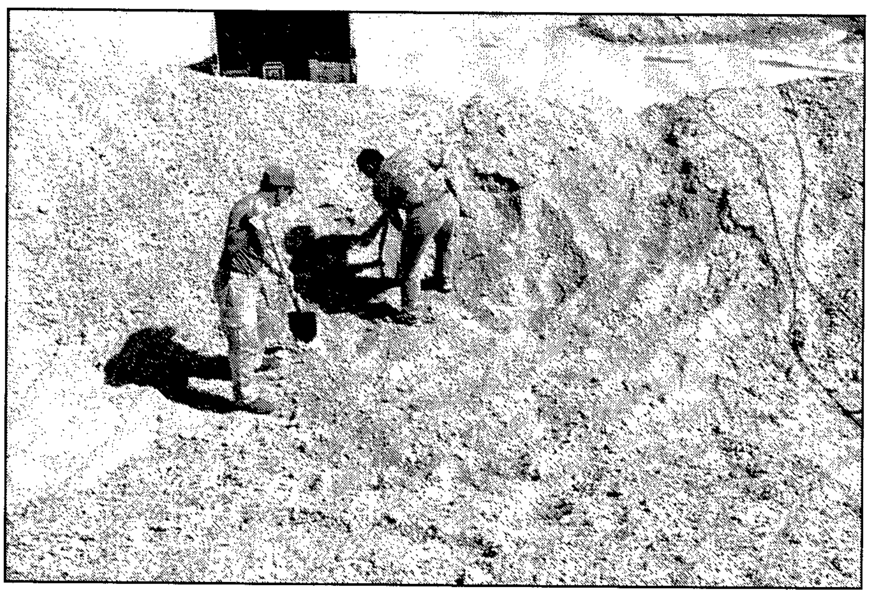

Figure 5. Crystal gypsum pile being prepared for GPR surveying

Powdered gypsum pile

An area near the toe of the powdered gypsum pile was prepared for testing as shown in Figure 8. The material was very fine-grained with the consistency of flour but with some cohesion (Figure 9). A sketch of the test layout is shown in Figure 10. The pipe and a 30 cm long piece of 5.1 cm by 10.2 cm lumber were buried at depths of approximately 20 and 15 cm, respectively. The GPR survey records for the powdered gypsum pile are presented in Appendix B. The

Figure 6. Example of crystal gypsum material showing grain size

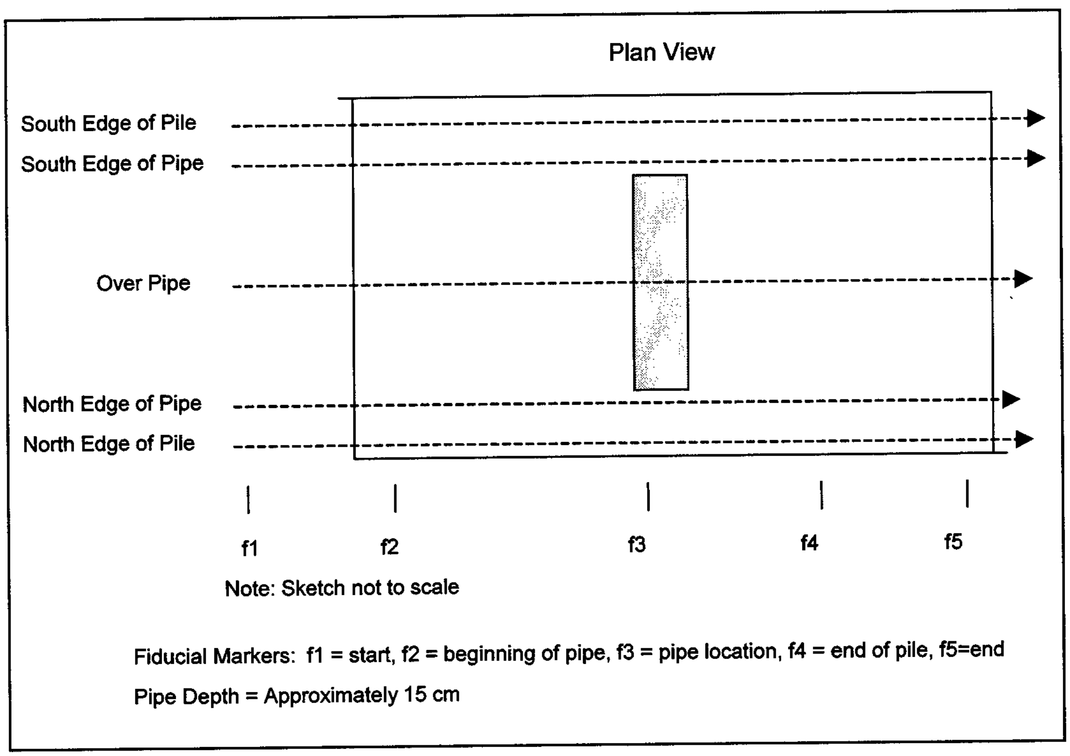

Figure 7. GPR survey line layout, crystal gypsum pile, initial investigation

Table 1
GPR Results, Crystal Gypsum, Initial Investigation

Antenna Frequency, MHz	System	File Name	Comments	Pipe Detected?
225	pE1000	CG225GP1	North edge of pile off of pipe	No
225	pE1000	CG225GP2	Over pipe	Yes
225	pE1000	CG225GP3	South edge of pipe	Yes
225	pE1000	CG225GP4	South edge of pile off of pipe	No
450	pE1000	CG450GP5	North edge of pile off of pipe	No
450	pE1000	CG450GP6	Over pipe	Yes
450	pE1000	CG450GP7	South edge of pipe	Yes
450	pE1000	CG450GP8	South edge of pile off of pipe	No
900	pE1000	CG900GP1	North edge of pile off of pipe	No
900	pE1000	CG900GP2	Over pipe	No
900	pE1000	CG900GP3	South edge of pipe	No
900	pE1000	CG900GP4	South edge of pile off of pipe	No
250	Noggin	CG250GP0	North edge of pile off of pipe	Yes
250	Noggin	CG250GP1	Over pipe	Yes
250	Noggin	CG250GP3	South edge of pipe	Yes
250	Noggin	CG250GP5	South edge of pile off of pipe	No

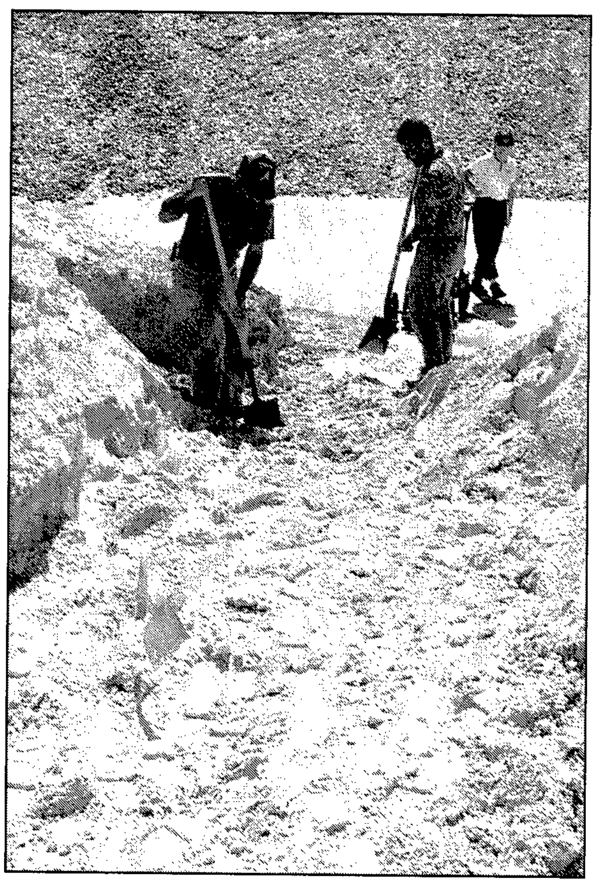

Figure 8. The powdered pumice pile being prepared for GPR surveying

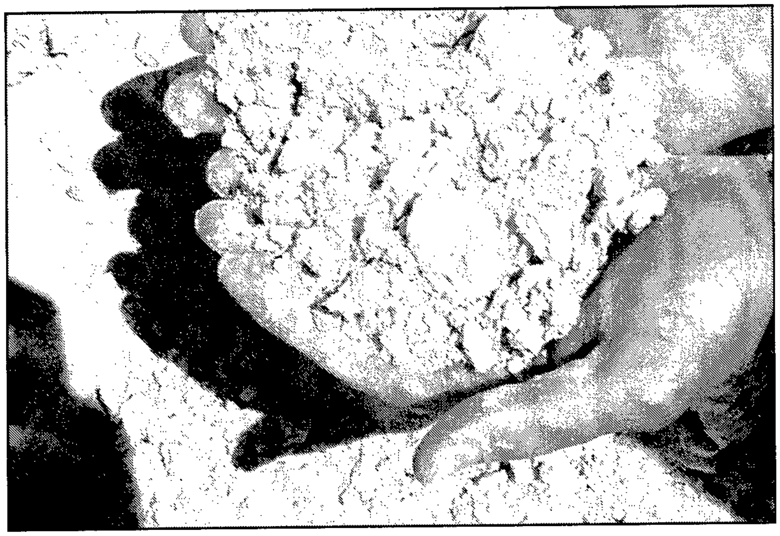

Figure 9. Image showing the fine-grained pumice with apparent cohesion

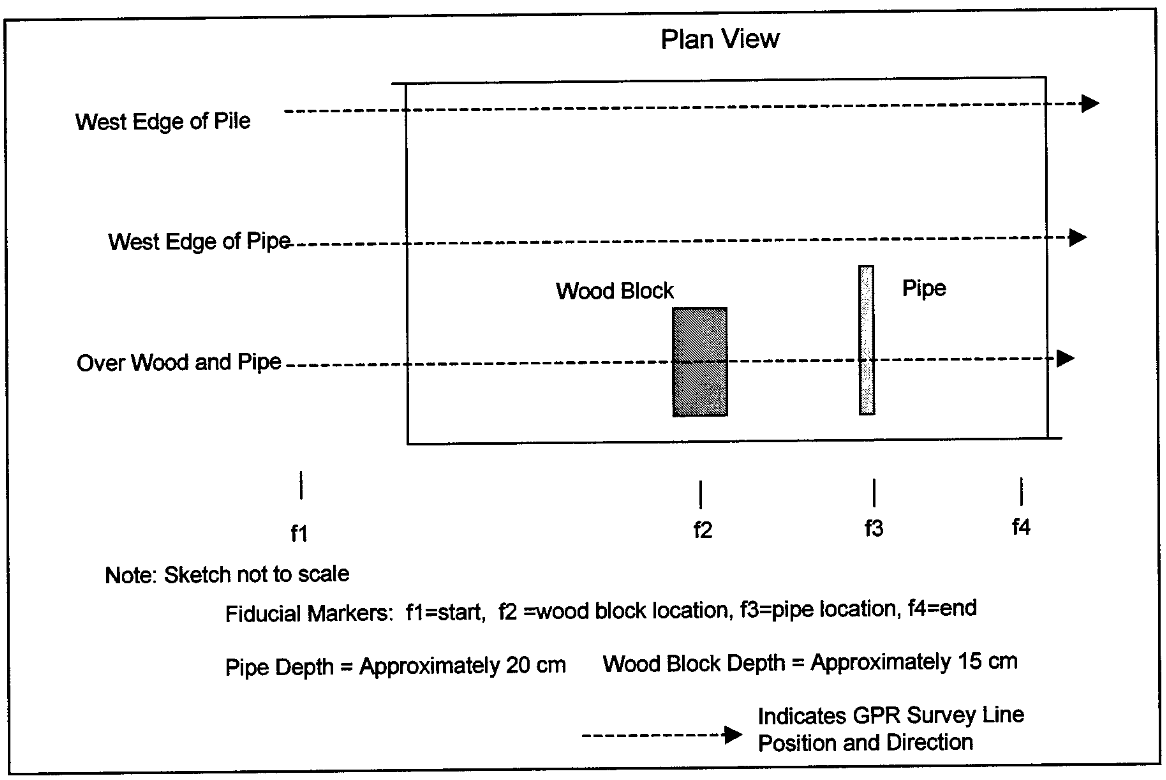

Figure 10. GPR survey layout, powdered gypsum pile, initial investigation

results of the GPR surveys are summarized in Table 2. Based on the strength of the signal returns, both GPR systems have at least a 1 m depth of investigation.

Table 2
GPR Results, Powdered Gypsum, Initial Investigation

Antenna Frequency, MHz	System	File Name	Comments	Pipe Detected?	Wood Block Detected?
225	pE1000	CG225PP1	West edge of pile	No	No
225	pE1000	CG225PP2	Over pipe	Yes	No
225	pE1000	CG225PP3	Over pipe	Yes	No
450	pE1000	CG450PP1	West edge of pile	No	No
450	pE1000	CG450PP2	Over pipe	No	No
450	pE1000	CG450PP3	Over pipe	No	No
900	pE1000	CG900PP1	West edge of pile	No	No
900	pE1000	CG900PP2	Over pipe	No	No
250	Noggin	CG250PP0	West edge of pile	No	No
250	Noggin	CG250PP1	West edge of pipe	Yes	No
250	Noggin	CG250PP2	Over pipe	Yes	Questionable
250	Noggin	CG250PP3	Over pipe	Yes	No

Crushed pumice pile

The survey lines for the crushed pumice were located at the toe of the pile as shown in Figure 11. The material consists of moderately sorted vesicular fine- to medium-grained pebble gravel in a fine- to medium-grained sand matrix (Figure 12). A sketch of the test layout is shown in Figure 13. The pipe and a 30 cm long piece of 5.1 cm by 10.2 cm lumber were buried at respective depths of approximately 24 and 30 cm. The GPR records for the surveys conducted on the crushed pumice pile are presented in Appendix C. The results of the GPR surveys are summarized in Table 3. The depth of investigation in this material is greater than 3 m.

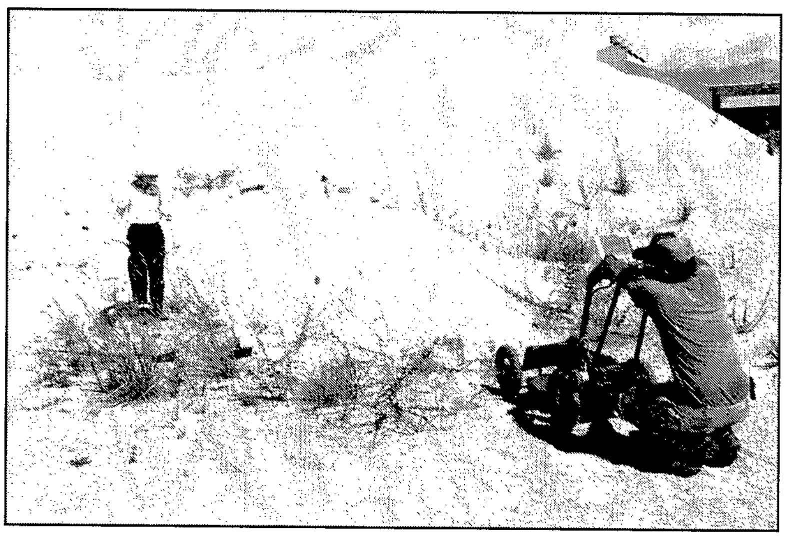

Figure 11. Location of GPR survey line, crushed pumice pile

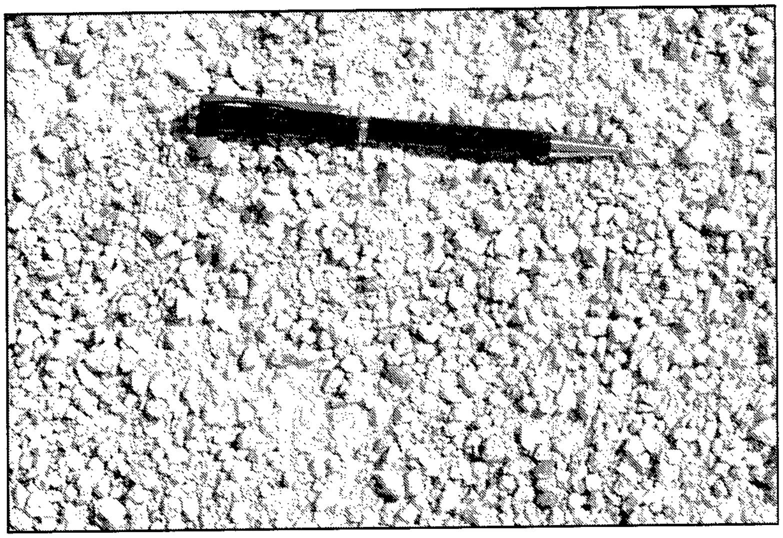

Figure 12. Image illustrating crushed pumice grain size

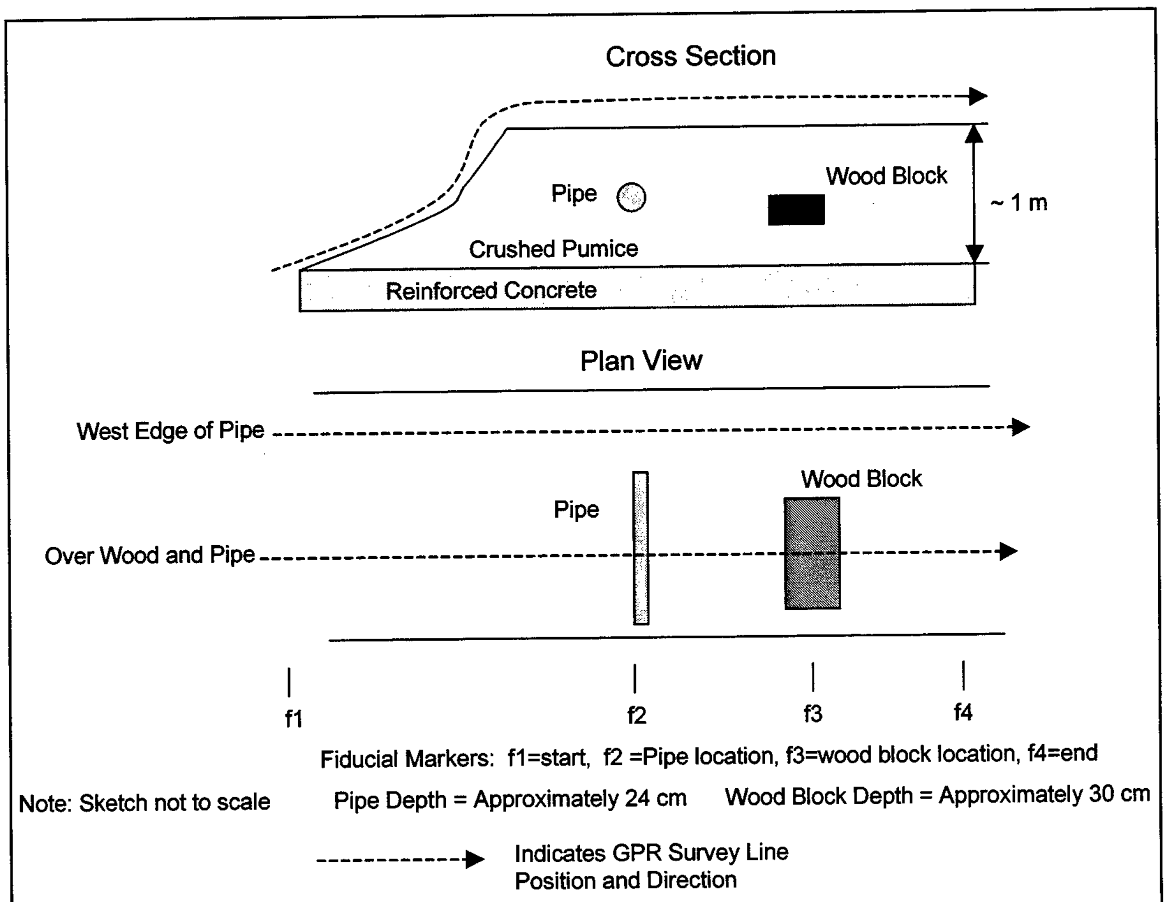

Figure 13. GPR survey layout, crushed pumice pile, initial investigation

Table 3 GPR Results, Crushed Pumice, Initial Investigation					
Antenna frequency, MHz	System	File name	Comments	Pipe detected?	Wood block detected?
225	pE1000	CG225MP1	West edge of pipe	No	No
225	pE1000	CG225MP2	Over pipe	Yes	No
450	pE1000	CG450MP1	West edge of pipe	No	No
450	pE1000	CG450MP2	Over pipe	Yes	No
900	pE1000	CG900MP1	West edge of pipe	No	No
900	pE1000	CG900MP2	Over pipe	No	No
250	Noggin	CG250MP0	West edge of pipe	No	No
250	Noggin	CG250MP1	Over pipe	Yes	No

Coarse coal pile

The survey lines for the coarse coal pile were located at the toe of the pile as shown in Figure 14. A sketch of the GPR survey layout is presented in Figure 15. The GPR records for the surveys conducted over the coal pile are presented in Appendix D. The results of the GPR surveys are summarized in Table 4. The pipe was difficult to distinguish with the Noggin and not detected with any of the pE antennas. The depth of investigation in this material is at least 1 m.

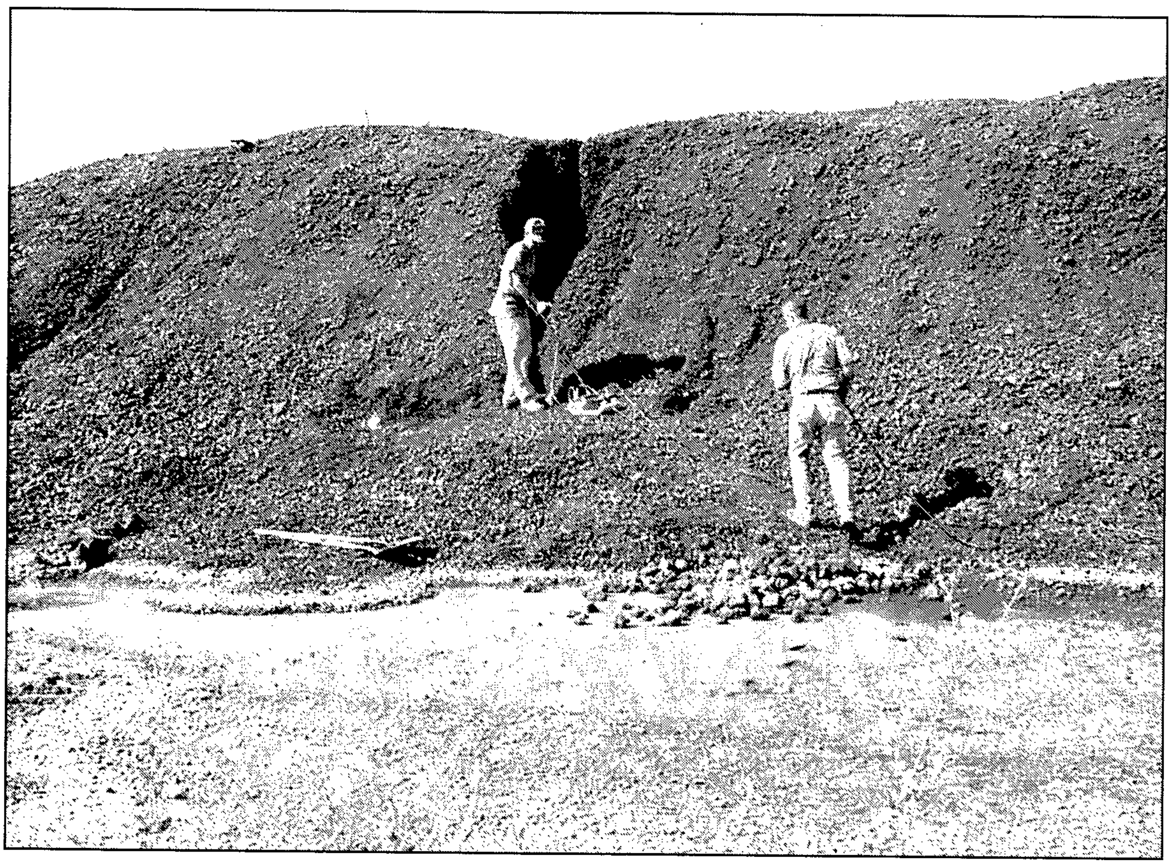

Figure 14. GPR survey being conducted at the toe of the coarse coal pile with the pE1000 system

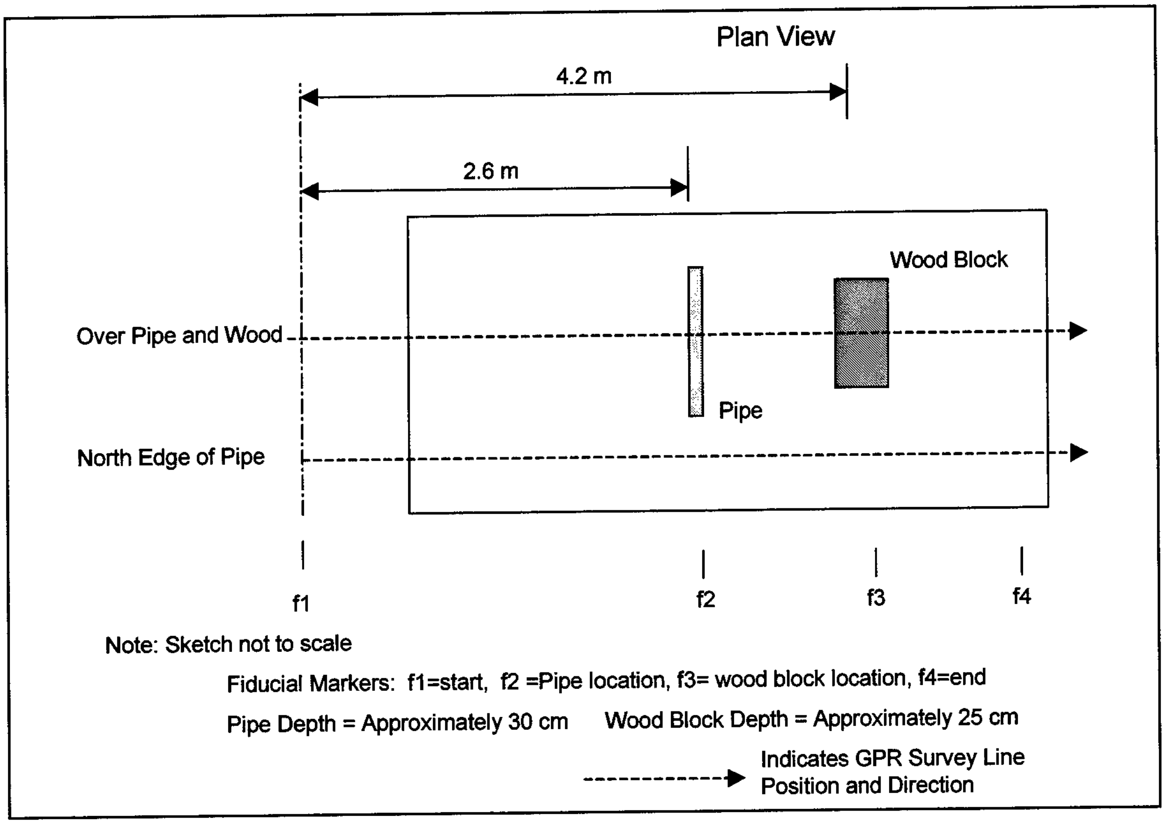

Figure 15. GPR survey line layout, coarse coal pile, initial investigation

Table 4
GPR Results, Coarse Coal, Initial Investigation

Antenna Frequency, MHz	System	File Name	Comments	Pipe Detected?	Wood Block Detected?
225	pE1000	CG225CP1	North edge of pipe	No	No
225	pE1000	CG225CP2	Over pipe	No	No
450	pE1000	CG450CP1	North edge of pipe	No	No
450	pE1000	CG450CP2	Over pipe	No	No
900	pE1000	CG900CP1	West edge of pipe	No	No
900	pE1000	CG900CP2	Over pipe	No	No
250	Noggin	CG250CP0	North edge of pipe	No	No
250	Noggin	CG250CP1	Over pipe	Yes	Yes
250	Noggin	CG250CP2	Over pipe	Yes	N/A[1]
250	Noggin	CG250CP3	Over pipe	Yes	Yes

[1] GPR survey line did not extend over wood block.

Buried Contraband Simulant Tests

The second phase of testing consisted of burying contraband simulants in stockpiled materials and determining the ability of GPR in detecting them. The simulant consisted of four 10-lb bags of sugar duct-taped together to form a 40-lb bundle as shown in Figure 16. The sugar bundles were buried in different stockpiled materials at a depth of about 40 cm and GPR profile lines run over the bundles in an attempt to detect the sugar or any evidence of disturbance caused

Figure 16. Two contraband simulants each consisting of four 10-lb bags of sugar duct-taped together

by digging and burying activities. The same GPR systems and antennas used in the first phase of testing were used in the second phase.

Crystal gypsum pile

The site was prepared by placing several lifts of crystal gypsum on the ground surface with a front-end loader to construct an area large enough on which to conduct the GPR surveys (Figure 17). The prepared area measured approximately 10 m long by 5 m wide and varied from about 0.3 to 1 m in height (Figure 18). A 40-lb bundle of sugar was buried near the middle of the prepared area to a depth of approximately 0.4 m and backfilled with crystal gypsum. A sketch of the test area showing the location of the GPR profile lines is presented Figure 19. The GPR records for the surveys conducted over the crystal gypsum are presented in Appendix E. The results of the GPR surveys are summarized in Table 5. The sugar bundle is visible using the Noggin system but is not readily detectable using the pE system.

Powdered gypsum pile

The site was prepared by placing, with a front-end loader, several lifts of powdered gypsum on the ground surface to construct an area large enough on which to conduct the GPR surveys. The prepared area measured approximately 8 m long by 4 m wide by 0.6 m high. Figure 20 shows the prepared tests site.

Figure 17. Contraband simulant being covered with crystal gypsum

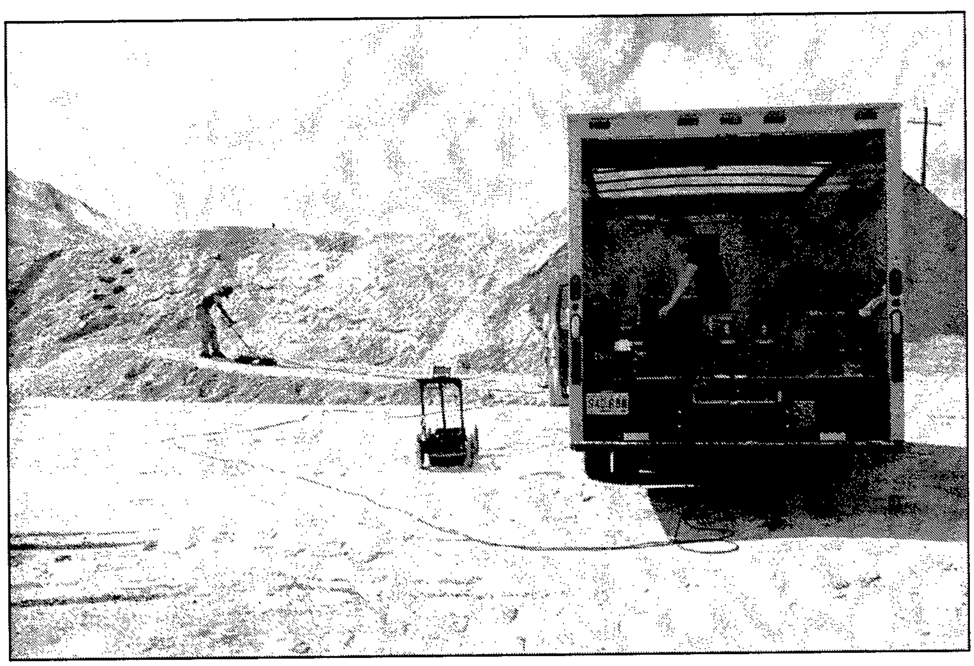

Figure 18. GPR survey being conducted over prepared crystal gypsum site

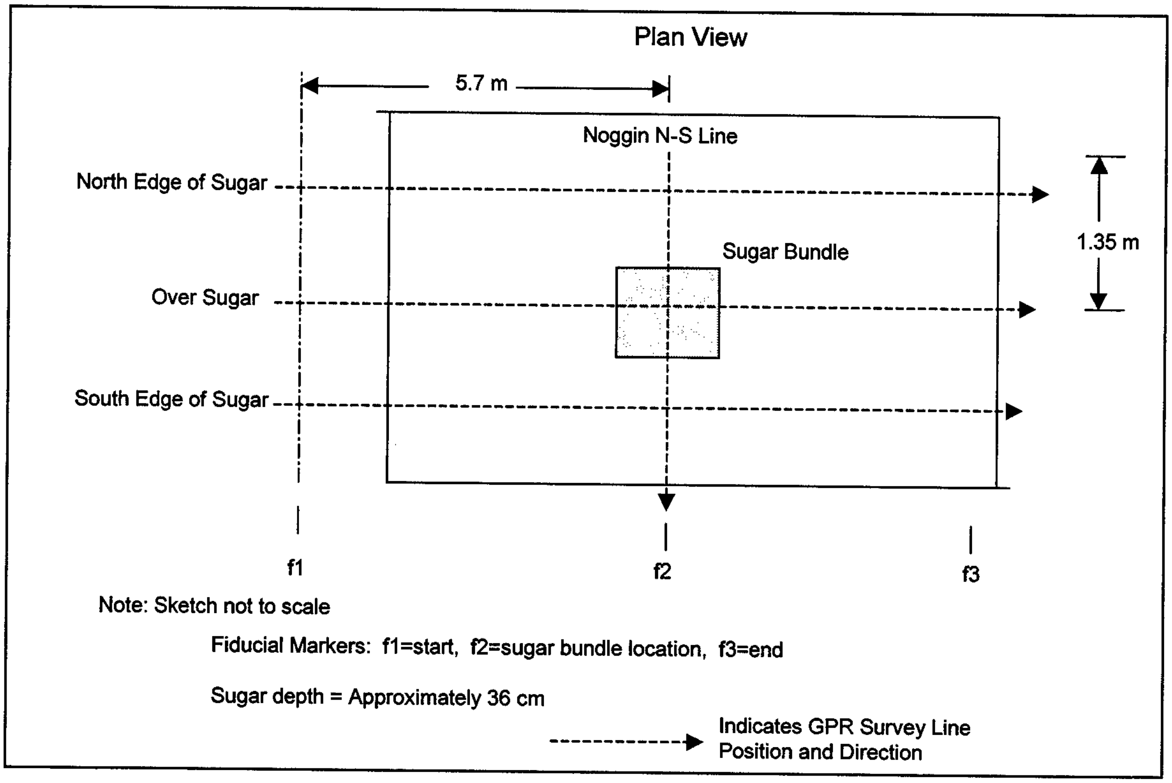

Figure 19. GPR survey line layout, crystal gypsum pile, buried contraband simulant tests

Table 5
GPR Results, Crystal Gypsum, Buried Contraband Simulant Tests

Antenna Frequency, MHz	System	File Name	Comments	Simulant Detected?
225	pE1000	CG225GS	North of sugar	No
225	pE1000	CG225GS2	North of sugar	No
225	pE1000	CG225GS3	Over sugar	No
225	pE1000	CG225GS4	Over sugar	No
225	pE1000	CG225GS5	South of sugar	No
450	pE1000	CG450GS1	North of sugar	No
450	pE1000	CG450GS2	Over sugar	No
450	pE1000	CG450GS3	South of sugar	No
900	pE1000	CG900GS1	North of sugar	No
900	pE1000	CG900GS2	Over sugar	No
900	pE1000	CG900GS3	South of sugar	No
250	Noggin	CG250GS0	North of sugar	Questionable
250	Noggin	CG250GS1	Over sugar	Yes
250	Noggin	CG250GS2	Over sugar	Yes
250	Noggin	CG250GS3	South edge of pile off of pipe	No
250	Noggin	CG250GS4	Over sugar (N-S line orientation)	Yes

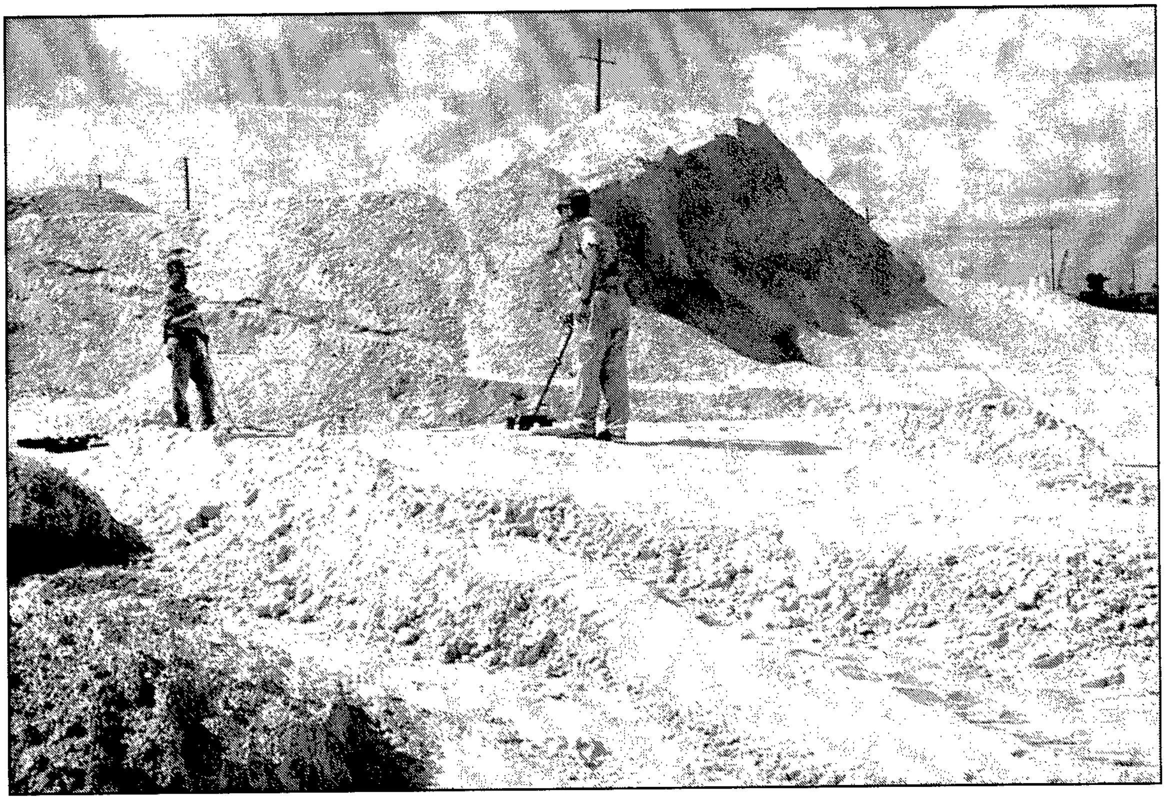

Figure 20. Powdered gypsum test site, buried simulant test

The bundle of sugar was buried near the middle of the prepared area to a depth of approximately 0.4 m and backfilled with powdered gypsum. The steel pipe was buried to a depth of approximately 25 cm near the sugar bundle as shown in Figure 21. The GPR records for the surveys conducted over the powdered gypsum are presented in Appendix F. The results of the GPR surveys are summarized in Table 6. The pE 225 MHz antenna and the Noggin system are able to locate the sugar bundle. The pipe was buried after the Noggin and prior to the pE systems being run over the site.

Crushed pumice pile

Testing was conducted on the same narrow ridge of pumice on the toe of the pumice pile as was used for locating the pipe in the initial investigations as shown in Figure 22. The 40-lb bundle of sugar was buried to a depth of 40 cm and backfilled with crushed pumice. All of the GPR profile lines were run over the buried sugar because of the limited testing area. A sketch of the test area showing the location of the GPR profile lines is presented Figure 23. The GPR records for the surveys conducted over the crushed pumice are presented in Appendix G. The results of the GPR surveys conducted over the crushed pumice are summarized in Table 7. The sugar bundle or soil disturbance can be detected using the Noggin and pE 225 and 450 MHz.

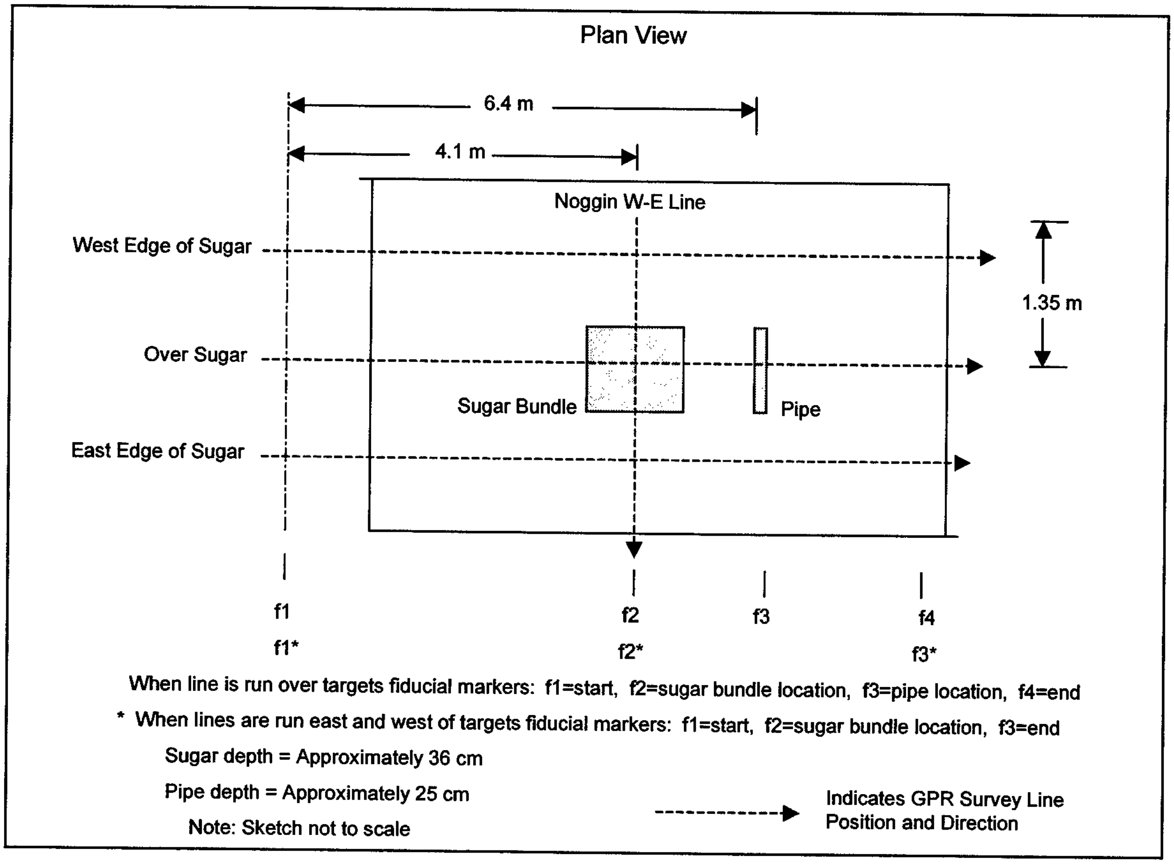

Figure 21. GPR survey line layout, powdered gypsum pile, buried contraband simulant test

Table 6
GPR Results, Powdered Gypsum, Buried Contraband Simulant Tests

Antenna Frequency, MHz	System	File Name	Comments	Simulant Detected?	Pipe Detected?
225	pE1000	CG225PS1	West of sugar	No	No
225	pE1000	CG225PS2	Over sugar	Yes	Yes
225	pE1000	CG225PS3	Over sugar	Yes	Yes
225	pE1000	CG225PS4	East of sugar	No	No
450	pE1000	CG450PS1	West of sugar	No	No
450	pE1000	CG450PS2	Over sugar	No	No
450	pE1000	CG450PS3	Over sugar	No	No
450	pE1000	CG450PS4	East of sugar	No	No
900	pE1000	CG900PS1	West of sugar	No	No
900	pE1000	CG900PS2	Over sugar	No	No
900	pE1000	CG900PS3	Over sugar	No	No
900	pE1000	CG900PS4	East of sugar	No	No
250	Noggin	CG250PS0	West of sugar	Yes	N/A[1]
250	Noggin	CG250PS1	Over sugar	Yes	N/A[1]
250	Noggin	CG250PS2	Over sugar	Yes	N/A[1]
250	Noggin	CG250PS3	East edge of pile off of pipe	No	N/A[1]
250	Noggin	CG250PS4	Over sugar (W-E line orientation)	Yes	N/A[1]

[1]Note: The pipe was not in-place during the Noggin system surveys.

Figure 22. pulseEKKO 1000 GPR survey over simulated contraband, crushed pumice

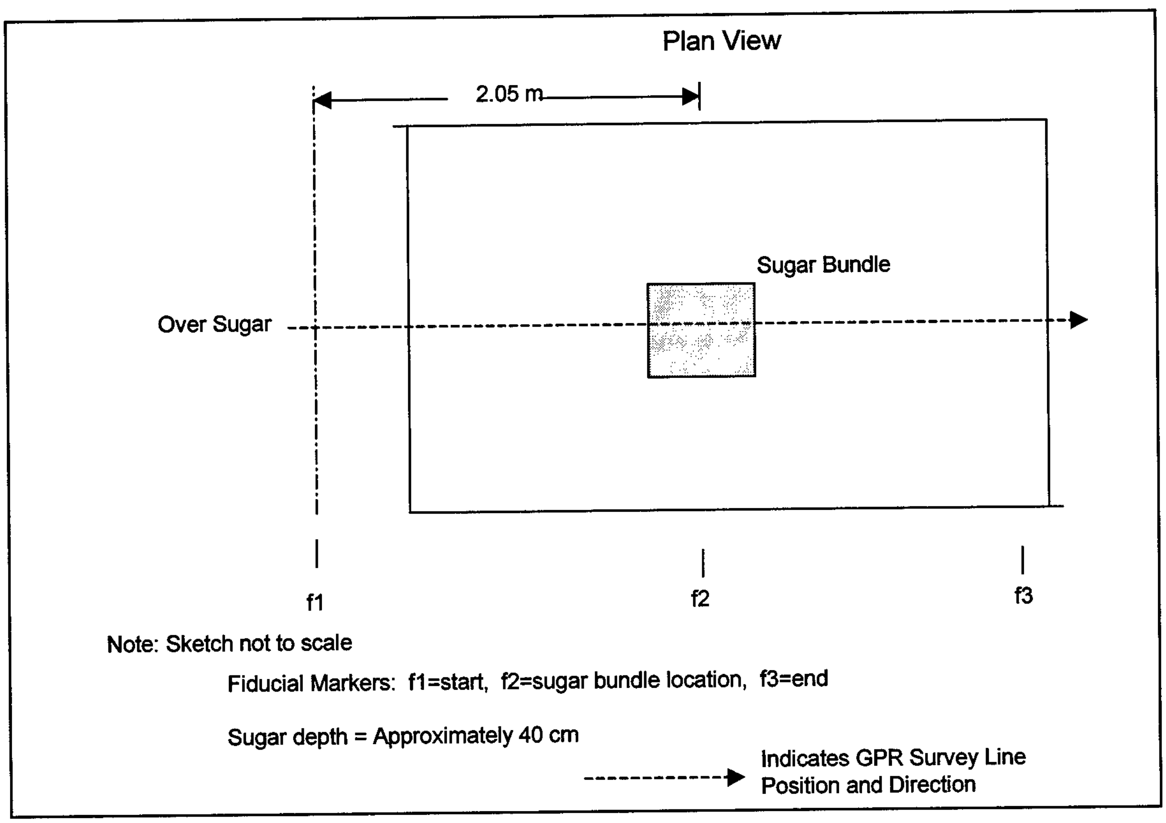

Figure 23. GPR survey line layout, crushed pumice pile, buried contraband simulant test

Table 7 GPR Results, Crushed Pumice, Buried Contraband Simulant Tests				
Antenna Frequency, MHz	System	File Name	Comments	Simulant Detected?
225	pE1000	CG225MS1	Over sugar	Yes
225	pE1000	CG225MS2	Over sugar	Yes
450	pE1000	CG450MS1	Over sugar	No
450	pE1000	CG450MS2	Over sugar	No
900	pE1000	CG900MS1	Over sugar	No
900	pE1000	CG900MS2	Over sugar	No
250	Noggin	CG250MS0	Over sugar	Yes
250	Noggin	CG250MS1	Over sugar	Yes

Bauxite pile

GPR tests were conducted along a 6-m-long track on the slope of a large bauxite pile as shown in Figure 24. The bauxite pile was not initially tested using a buried pipe, as was the case with the gypsum and pumice piles because this was an area with heavy truck traffic and access to the pile was limited to after regular work hours. Two holes were dug into the bauxite pile. The holes, one located 2.5 m from the survey start, was used to bury a 40-lb bundle of sugar and the other hole, located 4.1 m from the start, a steel pipe that measured 5.1 cm in diameter and 30.5 cm long. A sketch of the test area showing the location of the GPR profile lines is presented Figure 25. The GPR records for the surveys conducted over the bauxite pile are presented in Appendix H. The results of the GPR surveys conducted over the crushed pumice are summarized in Table 8. The buried steel pipe appears as a hyperbola and is easy to discern in the records of all the frequencies. Without prior knowledge of the location of the sugar bundle it would be difficult to distinguish its location in the GPR records. The sugar bundle signature can be seen in all of the records and is most clearly seen in the 450 MHz records, especially record CG450BS2.

Coal pile

GPR testing was conducted along an area just above the toe of a large pile of crushed coal (Figure 26). This coal pile was different than the one used for the initial buried pipe test. The coal in this pile was finer grained and in a looser density state because it had been recently been offloaded whereas the coal pile used in the initial investigations was coarser grained and the pile appeared to have been in place for months if not years. Two holes were dug into the coal pile. The holes, one located 2.2 m from the survey start, was used to bury a 40-lb bundle of sugar and the other hole, located 3.9 m from the start, a steel pipe that measured 5.1 cm in diameter and 30.5 cm long. The bundle of sugar and the steel pipe were buried at a depth of 0.35 m. A sketch of the test area showing the location of the GPR profile lines is presented Figure 27. The GPR records for the surveys conducted over the coal pile are presented in Appendix I. The results of the GPR surveys conducted over the coal are summarized in Table 9. The pipe is detected with all of the antennas. The higher frequency antennas provide greater resolution. The bundle of sugar is only detectable with the 450 and 900 MHz antennas.

Figure 24. Noggin GPR survey over simulated contraband, bauxite pile

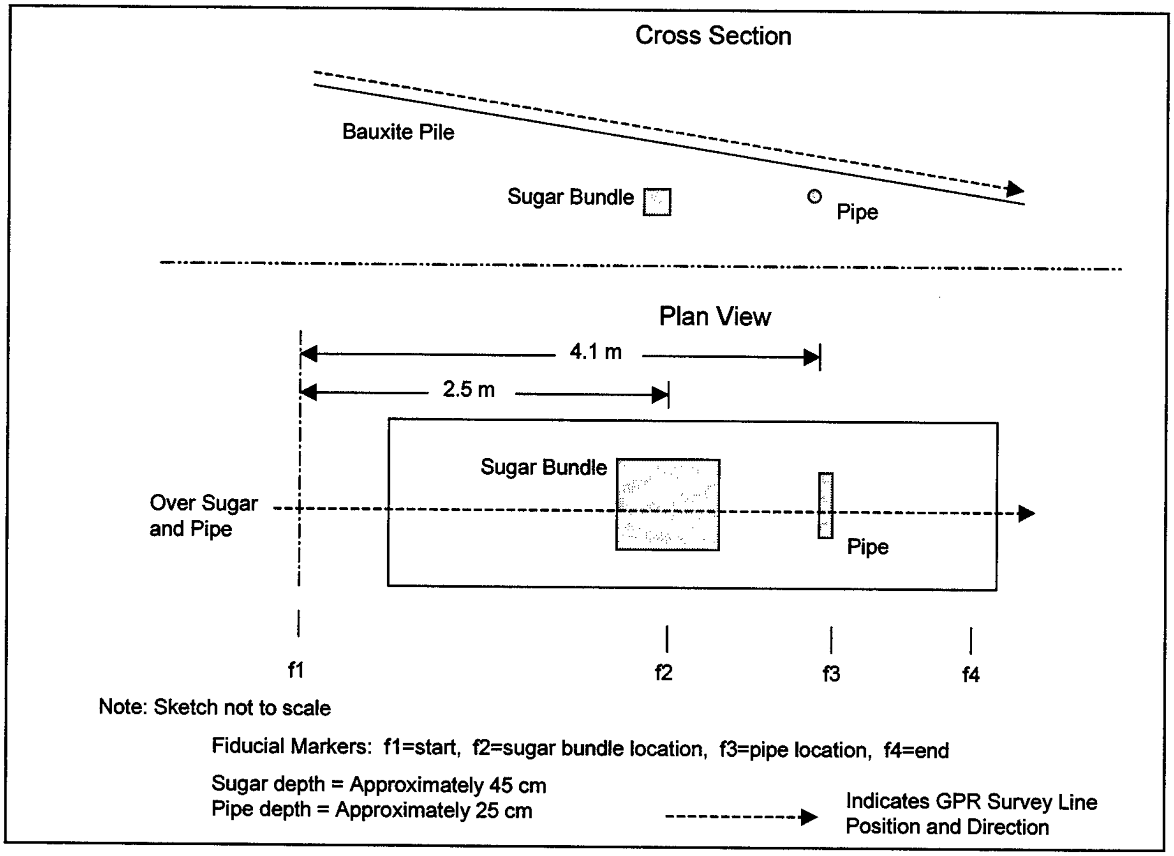

Figure 25. GPR survey line layout, bauxite pile, buried contraband simulant test

Table 8
GPR Results, Bauxite, Buried Contraband Simulant Tests

Antenna Frequency, MHz	System	File Name	Comments	Simulant Detected?	Pipe Detected?
225	pE1000	CG225BS1	Over sugar	Yes	Yes
225	pE1000	CG225BS2	Over sugar	Yes	Yes
450	pE1000	CG450BS1	Over sugar	Yes	Yes
450	pE1000	CG450BS2	Over sugar	Yes	Yes
900	pE1000	CG900BS1	Over sugar	Questionable	Yes
900	pE1000	CG900BS2	Over sugar	Questionable	Yes
250	Noggin	CG250BS0	Over sugar	Yes	Yes
250	Noggin	CG250BS1	Over sugar	Yes	Yes

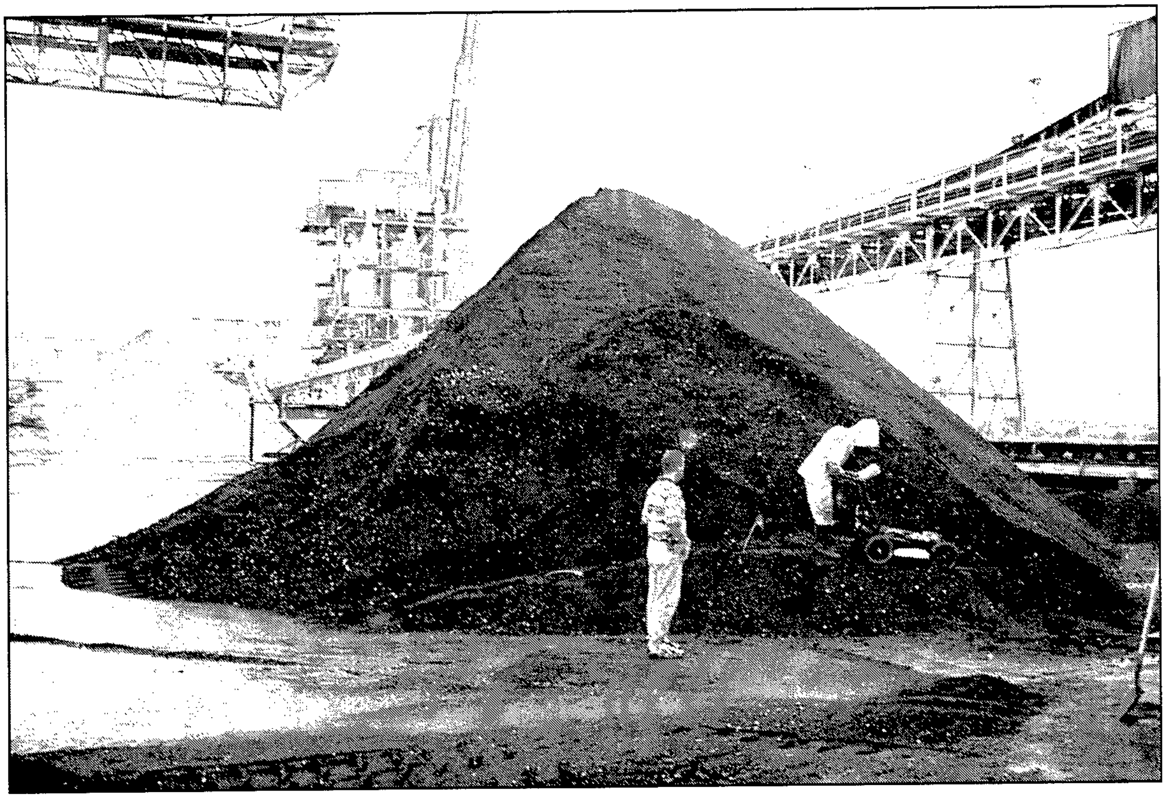

Figure 26. Noggin GPR survey over simulated contraband, coal pile

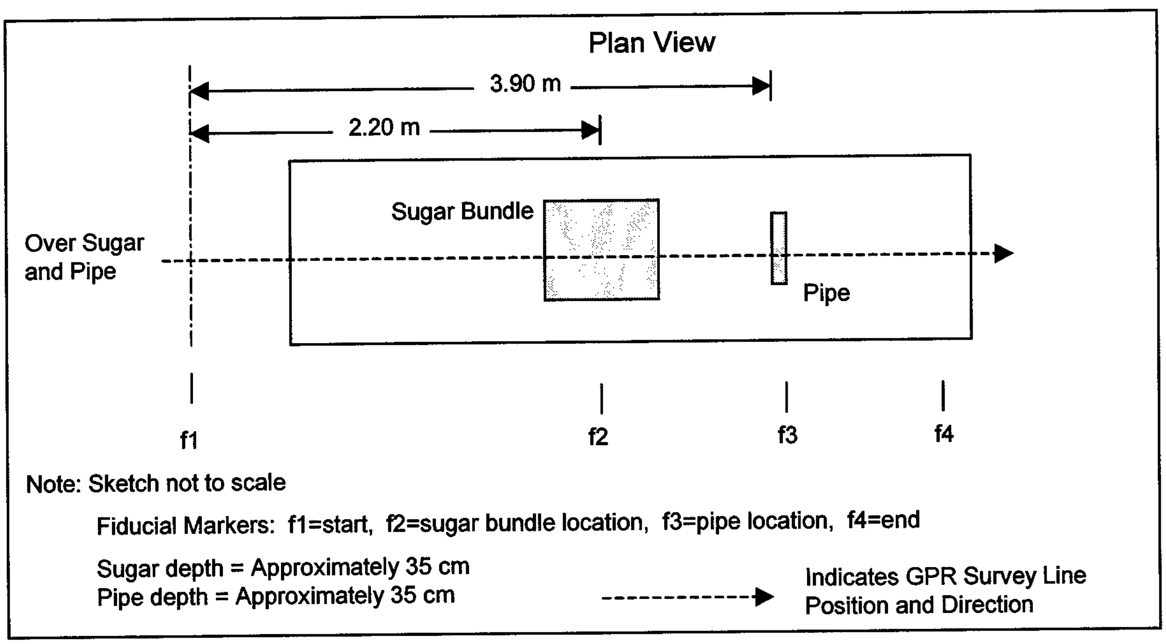

Figure 27. GPR survey line layout, coal pile, buried contraband simulant test

Table 9
GPR Results, Coal, Buried Contraband Simulant Tests

Antenna Frequency, MHz	System	File Name	Comments	Simulant Detected?	Pipe Detected?
225	pE1000	CG225LS1	Over sugar	No	Yes
225	pE1000	CG225LS2	Over sugar	No	Yes
450	pE1000	CG450LS1	Over sugar	Yes	Yes
450	pE1000	CG450LS2	Over sugar	Yes	Yes
900	pE1000	CG900LS1	Over sugar	Yes	Yes
900	pE1000	CG900LS2	Over sugar	Yes	Yes
250	Noggin	CG250LS0	Over sugar	No	Yes
250	Noggin	CG250LS1	Over sugar	No	Yes

Terrain Conductivity Tests

In addition to the GPR surveys, conductivity surveys were also conducted over the various test materials. The conductivity measurements were collected to determine if there was a correlation of conductivity to GPR depth of penetration or detection capability. A Geonics Ltd. EM38 terrain conductivity meter was used to collect the conductivity measurements (Figure 28). The measurements for the crystal and powdered gypsum and pumice were collected along the GPR survey lines used for the buried sugar experiments. The EM surveys were conducted by placing the meter in direct contact with the material and taking measurements every 0.5 m along the survey line. During the surveys it was noticed that the EM values for these materials were quite high. It was suspected that the metal rebar in the reinforced concrete slabs upon which the crystal and powdered gypsum, crushed pumice, and coarse coal piles are placed were affecting the conductivity readings. Spot conductivity measurements were taken at different elevations on the piles to collect readings not influenced by the metal rebar. Table 10 summarizes the conductivity values in millisiemens per meter (mS/m) for all the piles tested with the exception of the fine coal pile. Because of truck loading operations taking place by the fine coal pile, conductivity measurements were not taken. It is noted that, with the exception of the bauxite pile, the conductivity values taken along the GPR lines are significantly higher than those taken near the top of respective piles.

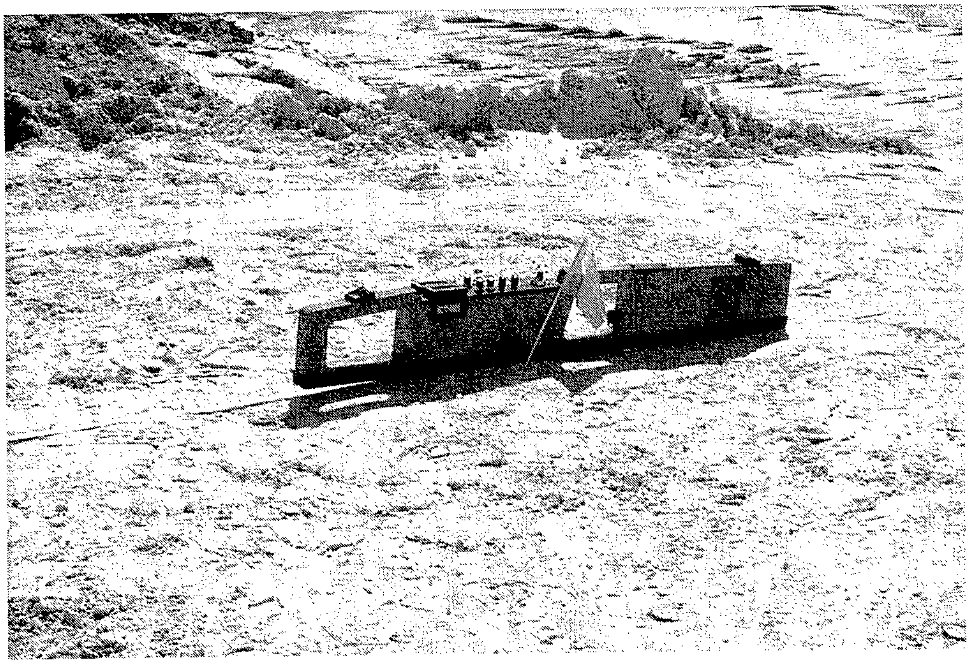

Figure 28. Geonics Ltd. EM38 terrain conductivity meter

Table 10
Conductivity Values for Different Test Pile Materials

Material Type	Range and Average Conductivity Values Along GPR Profile Line, mS/m	Conductivity Range on Pile, mS/m
Crystal gypsum	Range = 44-83 Average = 70	5-20; top of pile
Powdered gypsum	Range = 65-91 Average = 77	9-16; top of pile
Pumice	Range = 66-166 Average = 105	29-40; ½ way up pile 15; ¾ way up pile 8; top of pile
Coal (coarse)	Range = 110-140 Average = 125	85-128; ½ way up pile 63-84; ¾ way up pile
Bauxite	Range = 17-45 Average = 35	12-28; ½ way up pile

3 Discussion of Results

Ground penetrating radar surveys were run over several stockpiled materials to determine the effectiveness of GPR in detecting buried contraband material. Several items types were buried in the stockpiled materials and GPR surveys run over them to determine which antennas were the most effective in detecting the items in specific materials. The buried items consisted of a pipe, a block of wood, and bundled together bags of sugar. Table 11 summarizes the ability of the tested GPR antennas in detecting the buried objects in the different stockpiled materials. Table 11 pertains to surveys conducted directly over the buried items.

Table 11
Buried Items Detected with GPR Surveys in Different Stockpiled Materials

Antenna Frequency, MHz	Buried Item	Buried Item Detected in Stockpiled Material? Yes/No					
		Crystal Gypsum	Powdered Gypsum	Crushed Pumice	Coarse Coal	Bauxite	Coal
225	Steel Pipe	Yes	Yes	Yes	No	Yes	Yes
450	Steel Pipe	Yes	No	Yes	No	Yes	Yes
900	Steel Pipe	No	No	No	No	Yes	Yes
250[1]	Steel Pipe	Yes	Yes	Yes	Yes	Yes	Yes
225	Wood Block	N/A	No	No	No	N/A	N/A
450	Wood Block	N/A	No	No	No	N/A	N/A
900	Wood Block	N/A	No	No	No	N/A	N/A
250[1]	Wood Block	N/A	?	No	Yes	N/A	N/A
225	Sugar Bundle	No	Yes	Yes	N/A	Yes	No
450	Sugar Bundle	No	No	No	N/A	Yes	Yes
900	Sugar Bundle	No	No	No	N/A	?	Yes
250[1]	Sugar Bundle	Yes	Yes	Yes	N/A	Yes	No

[1]Denotes Noggin Plus System.

Referring to Table 11 it is seen that the GPR antennas perform differently in detecting the different buried objects in the various stockpiled materials. Table 12 shows the ability of the different antennas in detecting the steel pipe, wood block, and sugar bundle in the stockpiled materials.

Referring to Table 12 the steel pipe was the most readily detected object, as expected, and the wood block the most difficult. The 250 MHz antenna was the only antenna capable of detecting the wood block. In general, the 250 MHz antenna was the most effective antenna for detecting the buried items followed by, in the order of most effective in detecting the buried targets, the 225, 450,

Table 12
GPR Detection Capability for a Steel Pipe, Wood Block, and Sugar Bundle in Stockpiled Materials

Antenna Frequency, MHz	Percent Detection		
	Steel Pipe	Wood Block	Sugar Bundle
225	83	0	60
450	67	0	40
900	33	0	20
250*	100	33	80

* Denotes Noggin Plus System.

and 900 MHz antennas. The wood block was detected in the coarse coal and it is questionable whether it was detected in the powdered gypsum with the 250 MHz antenna.

With the exception of the initial tests conducted on the coarse gypsum pile, the GPR surveys were run over test sites prepared by placing relatively thin layers (1-2 m) of stockpiled material on the ground surface. Because of the relative thinness of the prepared test site and since many of the tests were conducted on reinforced concrete pads, a very good EM energy reflector, it is difficult to determine the maximum depth of penetration of the GPR for the various stockpiled materials. The survey records indicate that the GPR was able to penetrate through the entire thickness of all the tested materials to the top of the reinforced concrete. In order to determine the maximum depth of penetration in each of the materials GPR surveys would have to be conducted over increasing amounts of material until the reflecting concrete surface was no longer visible in the records.

4 Summary and Conclusions

Ground penetrating radar (GPR) surveys were conducted over various stockpiled materials at the Alabama State Docks located in Mobile, AL. The surveys were conducted to determine whether GPR is a viable method for rapidly detecting contraband materials buried in the cargo holds of ocean going vessels. The surveys were conducted by burying a steel pipe, a wood block, and a contraband simulant (a bundle of four 10-lb bags of sugar duct-taped together) in stockpiled materials available on site. The different materials reflect different amounts of radar energy back to the surface. The steel pipe was used because metal objects reflect one hundred percent of the radar energy that strikes it and should provide the easiest target to locate whereas, the wood block and sugar bundle, which were used as a more realistic target, reflect only a fraction of the radar energy that strikes them and therefore should be a more difficult target to detect. The materials tested were; gypsum crystal, powdered gypsum, crushed pumice, coarse coal, fine coal, and bauxite.

Two GPR systems manufactured by Sensors & Software, Inc, were used to conduct the surveys. The first system, the pulseEKKO 1000 system, was used with 225, 450, and 900 MHz antennas. The Noggin Plus was the second system used and it employed a 250 MHz antenna. Different frequency antennas were used to obtain different penetration depths and target resolution. The lower the GPR's antenna frequency the deeper it can search but less able it is to resolve smaller targets. High frequency GPR antennas cannot search as deep as the low frequency antennas but provide better definition of small buried targets within their search range. Therefore there is a trade-off between the search depth and the ability to resolve a target.

All of the antennas tested were successful in detecting the location of the contraband simulant in at least one of the stockpiled materials. The 225 and 250 MHz antennas had the highest percent of detecting the simulant in the stockpiled materials (40 and 80 percent, respectively) whereas the 900 MHz antenna had the lowest (20 percent). All of the antennas tested have penetration depths of greater than 1.5 m. Because of the way the test sections were configured the maximum depth of penetration for the antennas was not obtained.

Terrain conductivity values were collected for all the materials except for the fine coal pile. The conductivity values were taken to determine the effect of conductivity on the GPR's depth of penetration. In general, the lower the conductivity the greater the GPR depth of penetration. Since the maximum depth of

penetration could not be determined from the GPR surveys no correlation between conductivity values and penetration depth could be made.

The GPR surveys run on the different stockpiled materials at the Alabama State Docks demonstrate that GPR is a feasible means of locating contraband buried to depths of at least 1 to 2 m on ocean going vessels. However, the success of GPR in locating contraband material depends on the size of the target and the material in which it is hidden. The performance of GPR in different materials is dependent on the material's magnetic and electrical properties and therefore difficult to assess prior to deployment.

It is recommended that the U.S. Coast Guard consider using GPR for detecting contraband in the cargo holds of ships. It is also recommended that future GPR surveys be conducted using the Noggin system for the following reasons: (1) the Noggin system with the 250 MHz antenna performed better than the pE1000 system in detecting the sugar bundles, (2) it is easy to set-up, operate, and is fairly portable, (3) the antennas are shielded which means that the data would not be affected by reflections from overhead or nearby surfaces, (4) the antenna can be detached from the cart system to survey in tight areas, and (5) the system has a real-time display that is easy to read and interpret. An interchangeable 500 MHz antenna that may provide greater resolution is also available for the Noggin system.

Since it has been shown that GPR can be used in locating contraband simulants in various stockpiled materials under fairly ideal conditions the next step is to determine how it would perform under more realistic conditions such as those encountered aboard a ship. It is proposed that the Noggin system with the 250 and 500 MHz antennas be tested aboard a ship to assess its capabilities to detect buried simulants and also to assess any system deficiencies or problems, such as equipment portability, access issues, and potential sources of interference that may be affect the GPR.

Appendix A
Crystal Gypsum
GPR Records - Initial Investigation

pulseEKKO HEADER PARAMETERS

```
    FILE   = s:\COASTG~1\20SEP0~1\CG225GP1
    JOB#   =
    TITLE  = Alabama Shipyard, Bulk Handling Area
    TITLE  = Crystal Gypsum Pile, 225 MHz, Pipe - North Edge of Pile
    DATE   = 20/09/10
    NUMBER OF TRACES     = 210
    NUMBER OF PTS/TRC    = 200
    TIMEZERO AT POINT    = 40
    TOTAL TIME WINDOW    = 60
    STARTING POSITION    = 0.000
    FINAL POSITION       = 209.000
    STEP SIZE USED       = 1.000
    POSITION UNITS       = metres
    NOMINAL FREQUENCY    = 225.00
    ANTENNA SEPARATION   = 0.500
    PULSER VOLTAGE       = 200
    NUMBER OF STACKS     = 16
    SURVEY MODE          = Reflection
    COLLECTED BY PE1000 - CON: 981119 RX: 981120
                          TX: 981121 ANT: 971195/96

PROCESSING SELECTED
    FILTERS:    TRACE STACKING: 2
                POINT STACKING: 2
                TRACE DIFFERENCING: N
                CORRECTION: DEWOW
    SELECTION   TIME: -12 to 48
                POSITIONS: 0.000 to 209.000
    GAINS:      GAIN TYPE: CONSTANT
                MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.0500 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
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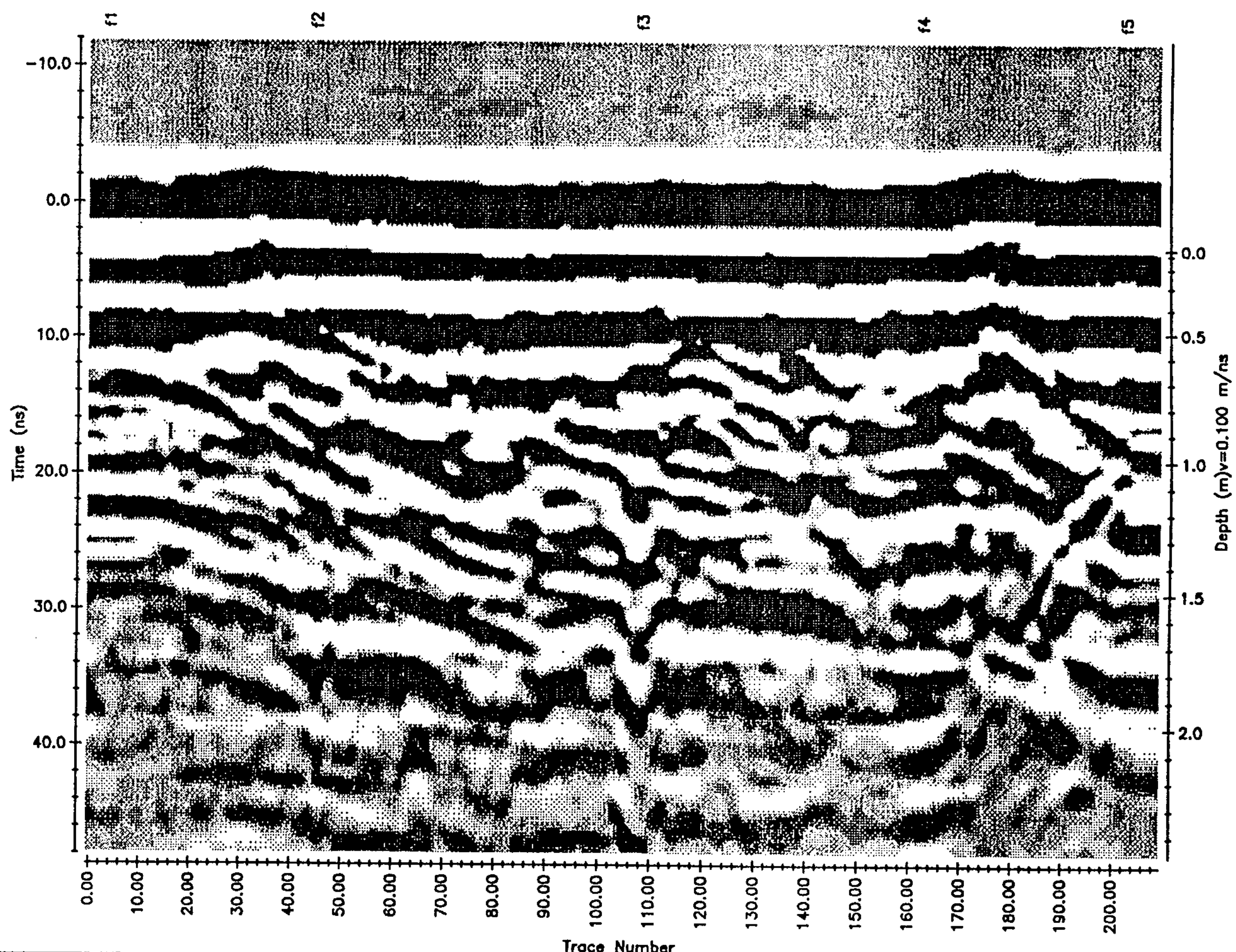

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pulseEKKO HEADER PARAMETERS
    FILE  = s:\COASTG~1\20SEP0~1\CG225GP2
    JOB#  =
    TITLE = Alabama Shipyard, Bulk Handling Area
    TITLE = Crystal Gypsum Pile, 225 MHz, Pipe - Profile Over Pipe
    DATE  = 20/09/10
    NUMBER OF TRACES     = 191
    NUMBER OF PTS/TRC    = 200
    TIMEZERO AT POINT    = 40
    TOTAL TIME WINDOW    = 60
    STARTING POSITION    = 0.000
    FINAL POSITION       = 190.000
    STEP SIZE USED       = 1.000
    POSITION UNITS       = metres
    NOMINAL FREQUENCY    = 225.00
    ANTENNA SEPARATION   = 0.500
    PULSER VOLTAGE       = 200
    NUMBER OF STACKS     = 16
    SURVEY MODE          = Reflection
    COLLECTED BY PE1000 - CON: 981119 RX: 981120
                          TX: 981121 ANT: 971195/96

PROCESSING SELECTED
    FILTERS:     TRACE STACKING: 2
                 POINT STACKING: 2
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
    SELECTION    TIME: -12 to 48
                 POSITIONS: 0.000 to 190.000
    GAINS:       GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000


PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.0500 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
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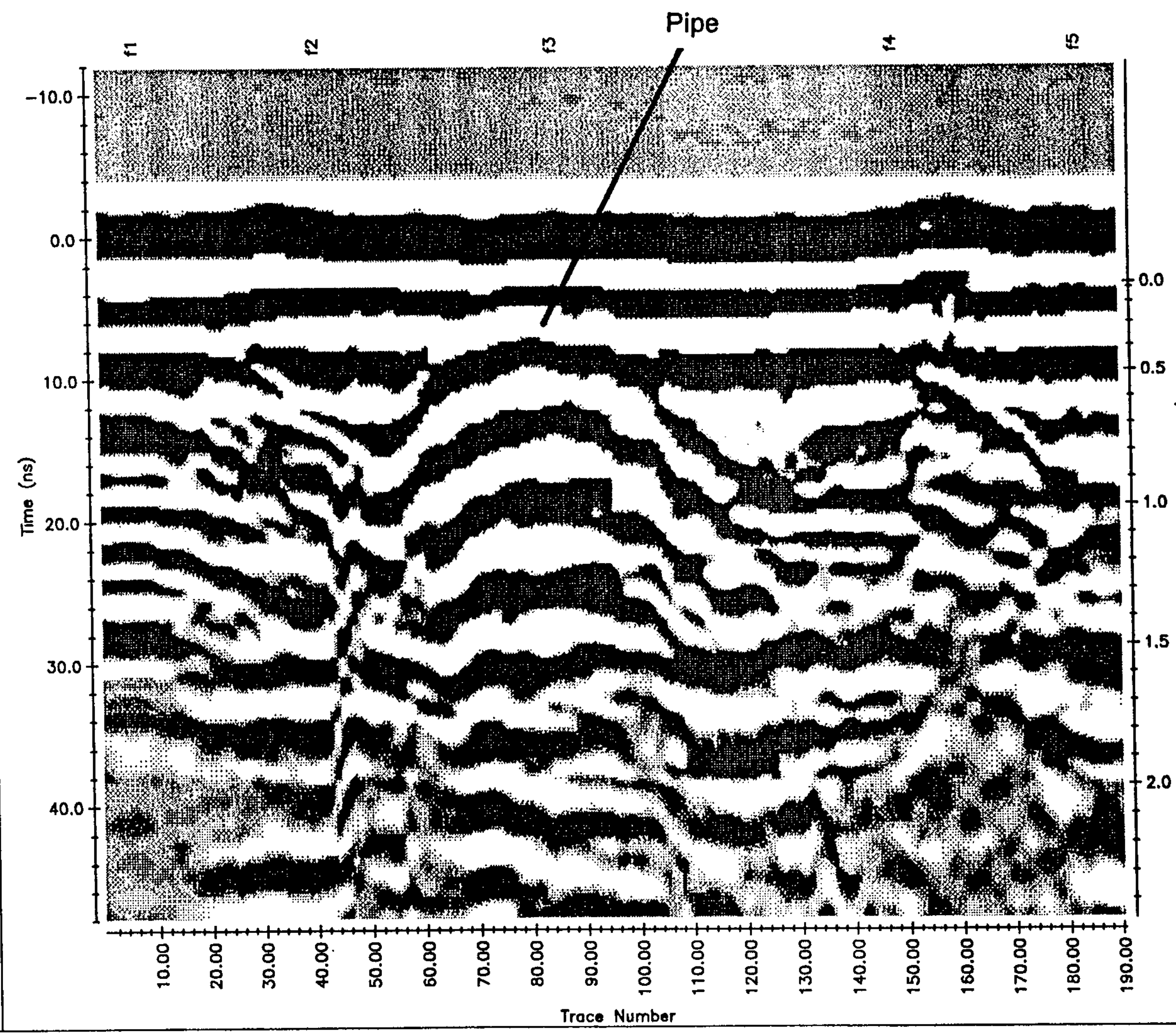

pulseEKKO HEADER PARAMETERS

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     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Crystal Gypsum Pile, 225 MHz, Pipe - South Edge of Pipe
     DATE   = 20/09/10
     NUMBER OF TRACES     = 138
     NUMBER OF PTS/TRC    = 250
     TIMEZERO AT POINT    = 43
     TOTAL TIME WINDOW    = 75
     STARTING POSITION    = 0.000
     FINAL POSITION       = 137.000
     STEP SIZE USED       = 1.000
     POSITION UNITS       = metres
     NOMINAL FREQUENCY    = 225.00
     ANTENNA SEPARATION   = 0.500
     PULSER VOLTAGE       = 200
     NUMBER OF STACKS     = 16
     SURVEY MODE          = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971195/96

PROCESSING SELECTED
     FILTERS:    TRACE STACKING: 2
                 POINT STACKING: 2
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
     SELECTION   TIME: -12 to 63
                 POSITIONS: 0.000 to 137.000
     GAINS:      GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
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     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
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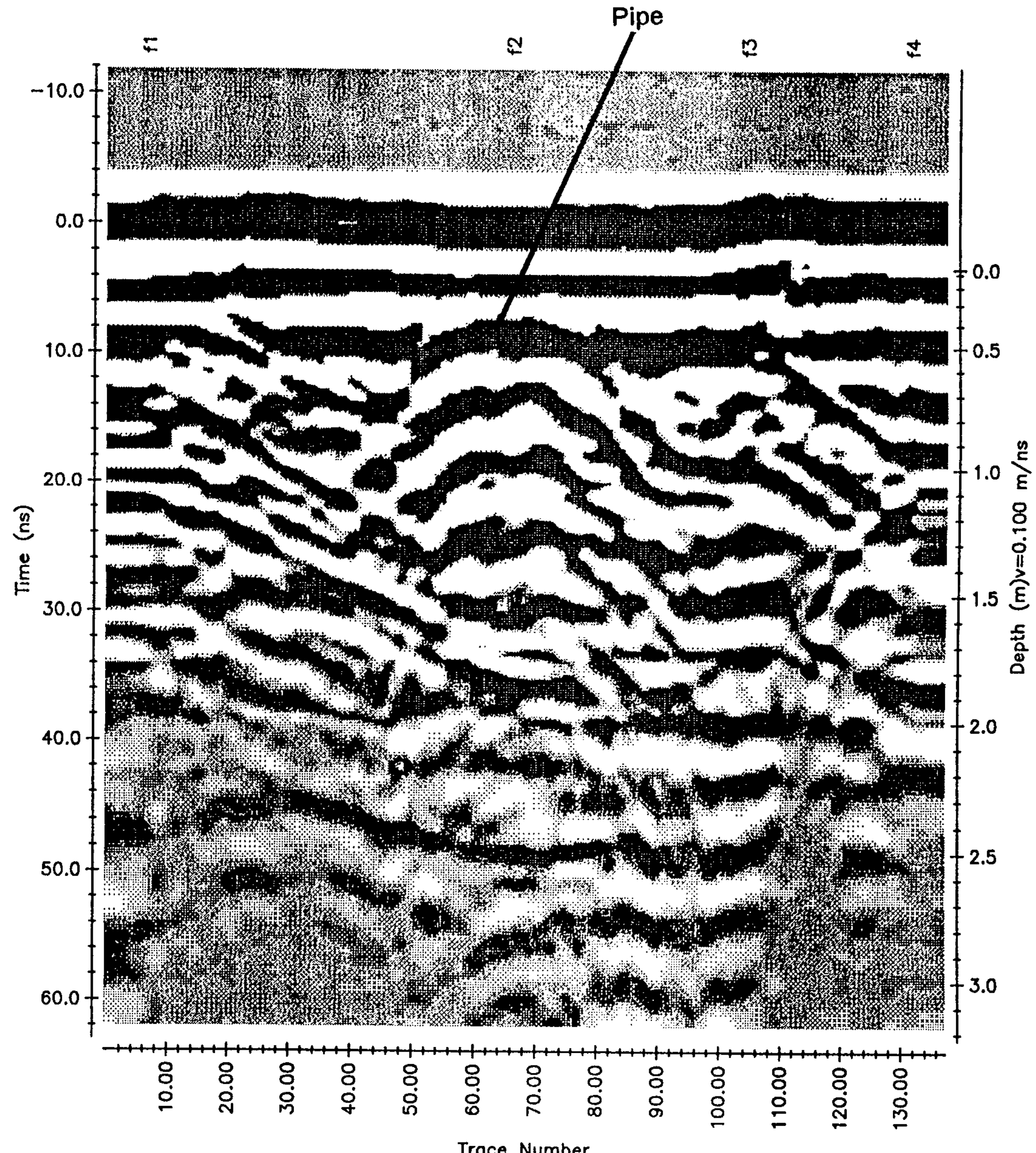

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JOB# =
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TITLE = Crystal Gypsum Pile, 225 MHz, Pipe – South Edge of Pile
DATE = 20/09/10
NUMBER OF TRACES = 127
NUMBER OF PTS/TRC = 250
TIMEZERO AT POINT = 44
TOTAL TIME WINDOW = 75
STARTING POSITION = 0.000
FINAL POSITION = 126.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 225.00
ANTENNA SEPARATION = 0.500
PULSER VOLTAGE = 200
NUMBER OF STACKS = 16
SURVEY MODE = Reflection
COLLECTED BY PE1000 – CON: 981119 RX: 981120
TX: 981121 ANT: 971195/96

PROCESSING SELECTED
FILTERS: TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: −13 to 62
POSITIONS: 0.000 to 126.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0500 and 0.2500
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MARGIN LEFT AND RIGHT: −0.5000 and 1.0000
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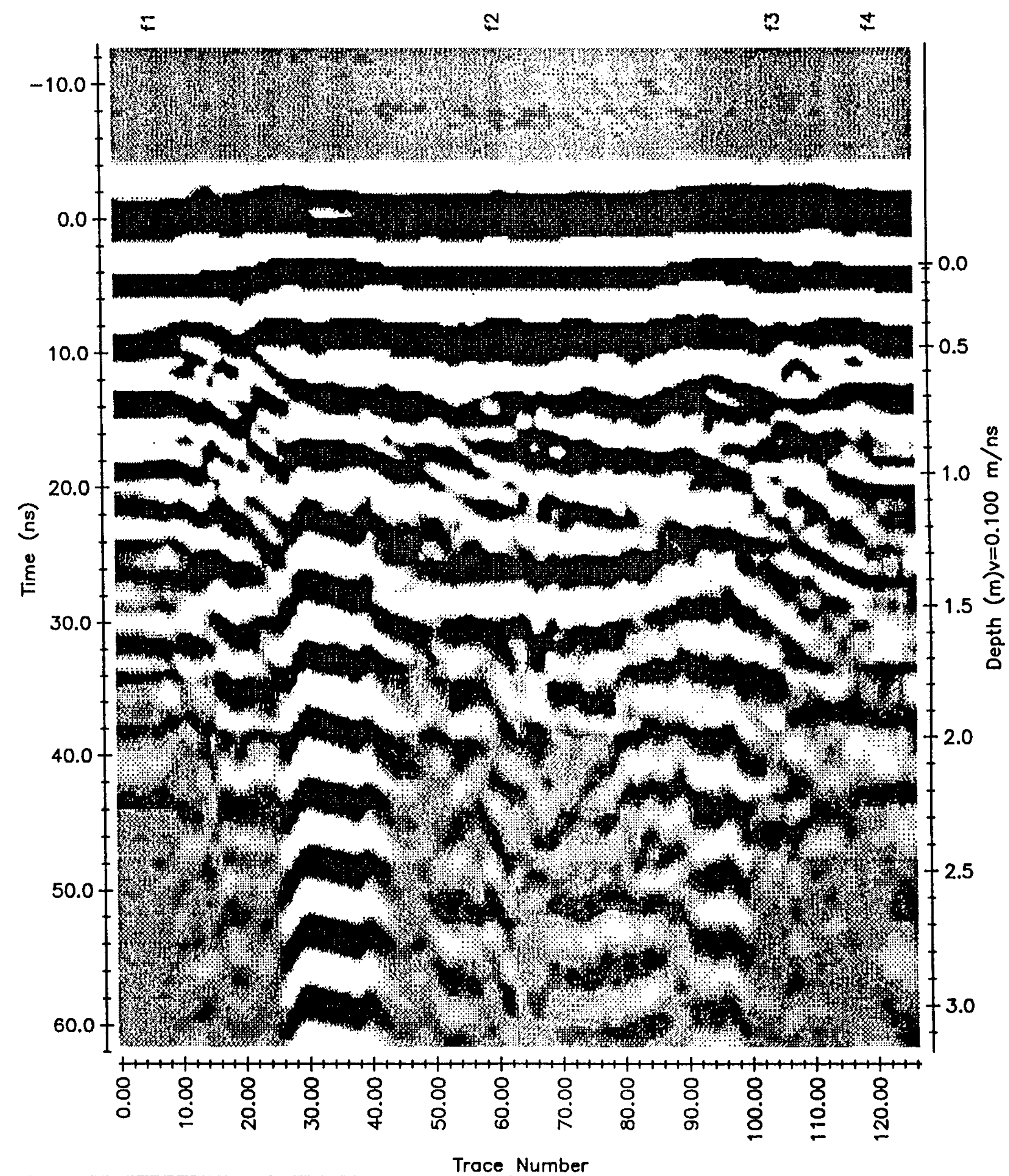

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     TITLE  = Crystal Gypsum Pile, 450 MHz, Pipe - North Edge of Pile
     DATE   = 20/09/10
     NUMBER OF TRACES      = 91
     NUMBER OF PTS/TRC     = 500
     TIMEZERO AT POINT     = 90
     TOTAL TIME WINDOW     = 50
     STARTING POSITION     = 0.000
     FINAL POSITION        = 90.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 450.00
     ANTENNA SEPARATION    = 0.250
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 16
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971181/82

PROCESSING SELECTED
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                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -9 to 41
                  POSITIONS: 0.000 to 90.000
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
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     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
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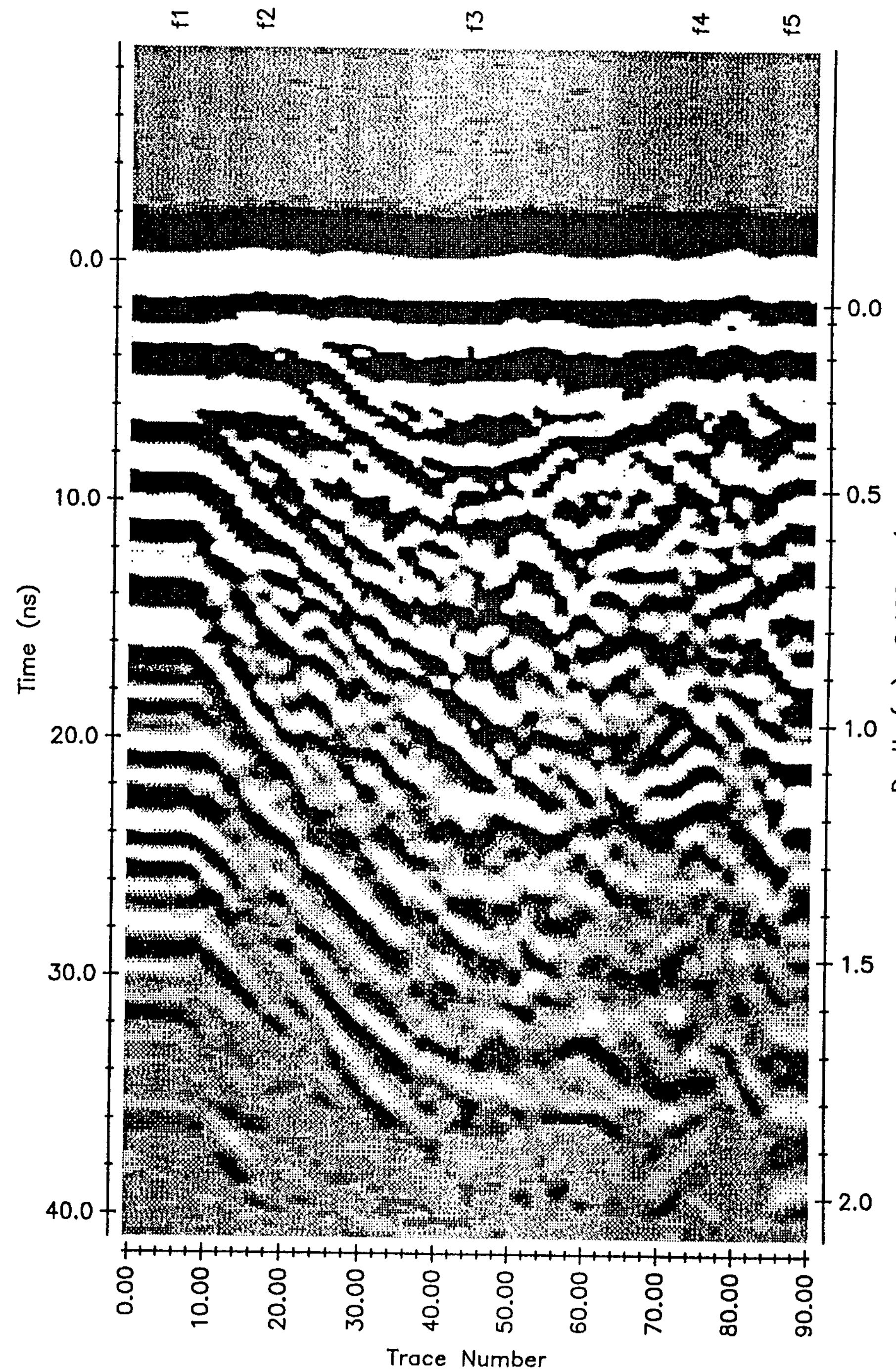

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     TITLE = Crystal Gypsum Pile, 450 MHz, Pipe - Profile Over Pipe
     DATE  = 20/09/10
     NUMBER OF TRACES      = 80
     NUMBER OF PTS/TRC     = 500
     TIMEZERO AT POINT     = 89
     TOTAL TIME WINDOW     = 50
     STARTING POSITION     = 0.000
     FINAL POSITION        = 79.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 450.00
     ANTENNA SEPARATION    = 0.250
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 16
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971181/82

PROCESSING SELECTED
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                   POINT STACKING: 2
                   TRACE DIFFERENCING: N
                   CORRECTION: DEWOW
     SELECTION     TIME: -8 to 42
                   POSITIONS: 0.000 to 79.000
     GAINS:        GAIN TYPE: CONSTANT
                   MULTIPLIER: 100.000


PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0700 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
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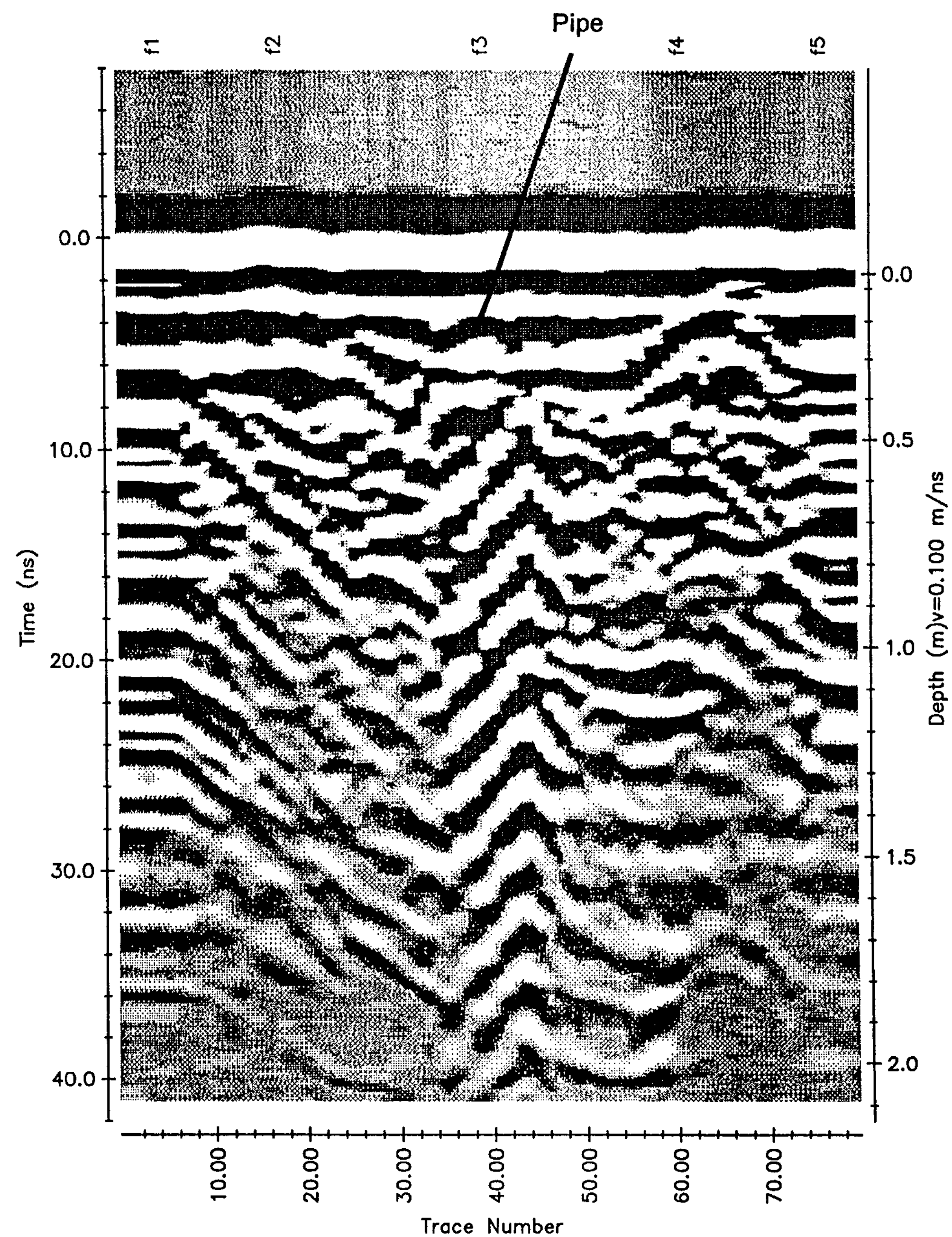

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     TITLE   = Crystal Gypsum Pile, 450 MHz, Pipe - Over South Edge of Pipe
     DATE    = 20/09/10
     NUMBER OF TRACES      = 81
     NUMBER OF PTS/TRC     = 500
     TIMEZERO AT POINT     = 89
     TOTAL TIME WINDOW     = 50
     STARTING POSITION     = 0.000
     FINAL POSITION        = 80.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 450.00
     ANTENNA SEPARATION    = 0.250
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 16
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971181/82

PROCESSING SELECTED
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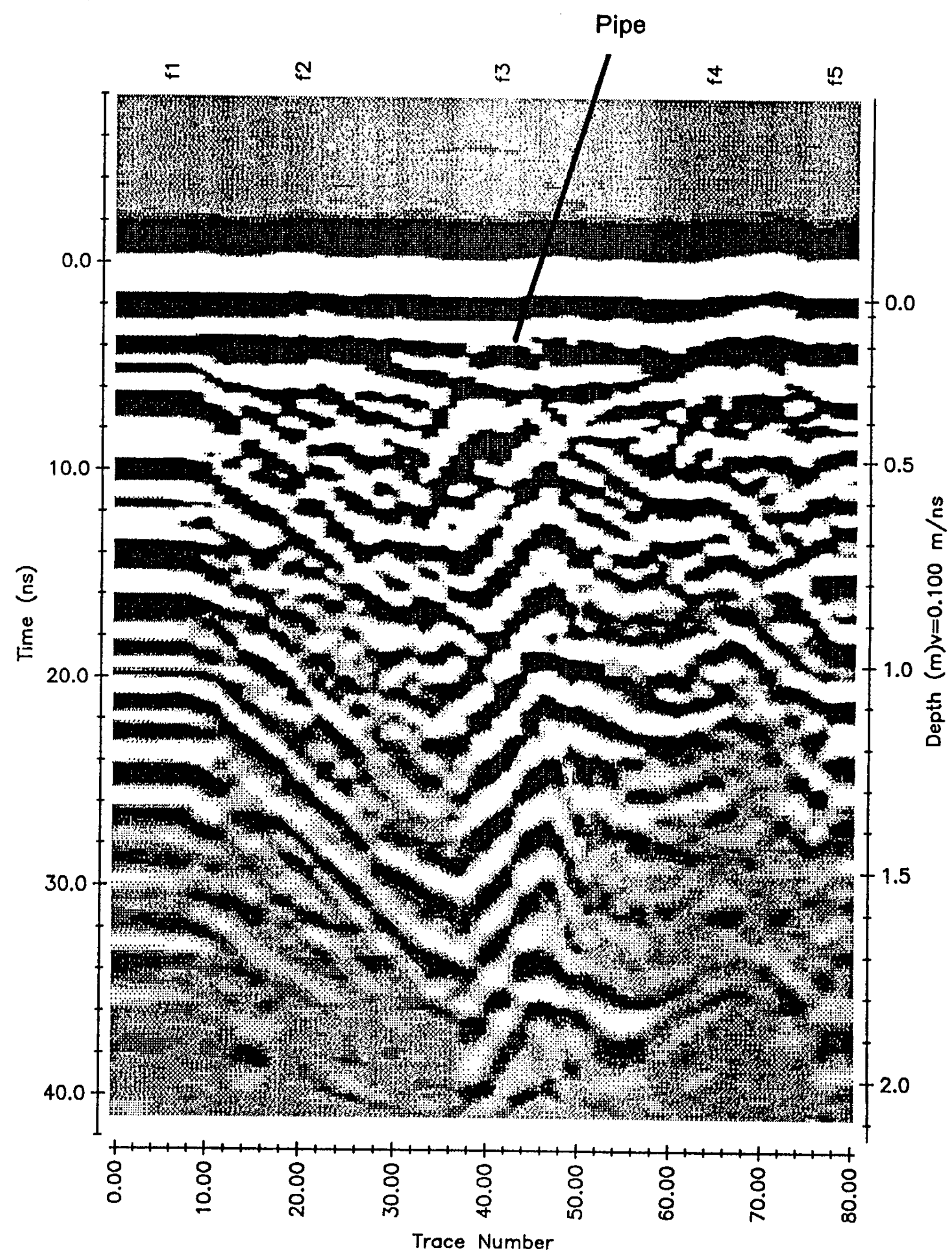
                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -8 to 42
                  POSITIONS: 0.000 to 80.000
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0700 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000 and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

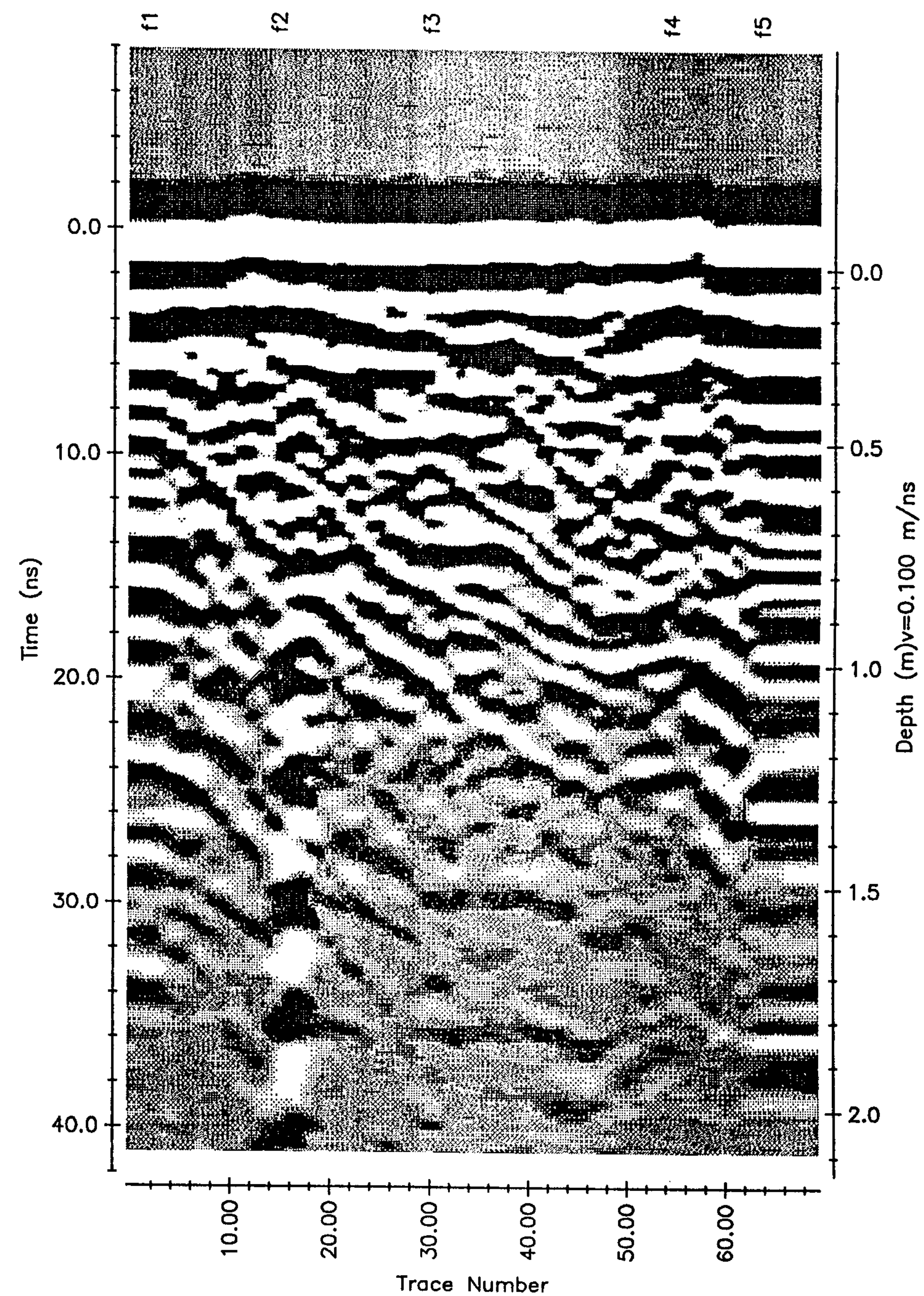
FILE	=	s:\COASTG~1\20SEP0~1\CG450GP8
JOB#	=	
TITLE	=	Alabama Shipyard, Bulk Handling Area
TITLE	=	Crystal Gypsum Pile, 450 MHz, Pipe -- South Edge of Pile
DATE	=	20/09/10
NUMBER OF TRACES	=	70
NUMBER OF PTS/TRC	=	500
TIMEZERO AT POINT	=	89
TOTAL TIME WINDOW	=	50
STARTING POSITION	=	0.000
FINAL POSITION	=	69.000
STEP SIZE USED	=	1.000
POSITION UNITS	=	metres
NOMINAL FREQUENCY	=	450.00
ANTENNA SEPARATION	=	0.250
PULSER VOLTAGE	=	200
NUMBER OF STACKS	=	16
SURVEY MODE	=	Reflection

COLLECTED BY PE1000 -- CON: 981119 RX: 981120
TX: 981121 ANT: 971181/82

PROCESSING SELECTED

FILTERS:	TRACE STACKING: 2
	POINT STACKING: 2
	TRACE DIFFERENCING: N
	CORRECTION: DEWOW
SELECTION	TIME: -8 to 42
	POSITIONS: 0.000 to 69.000
GAINS:	GAIN TYPE: CONSTANT
	MULTIPLIER: 100.000

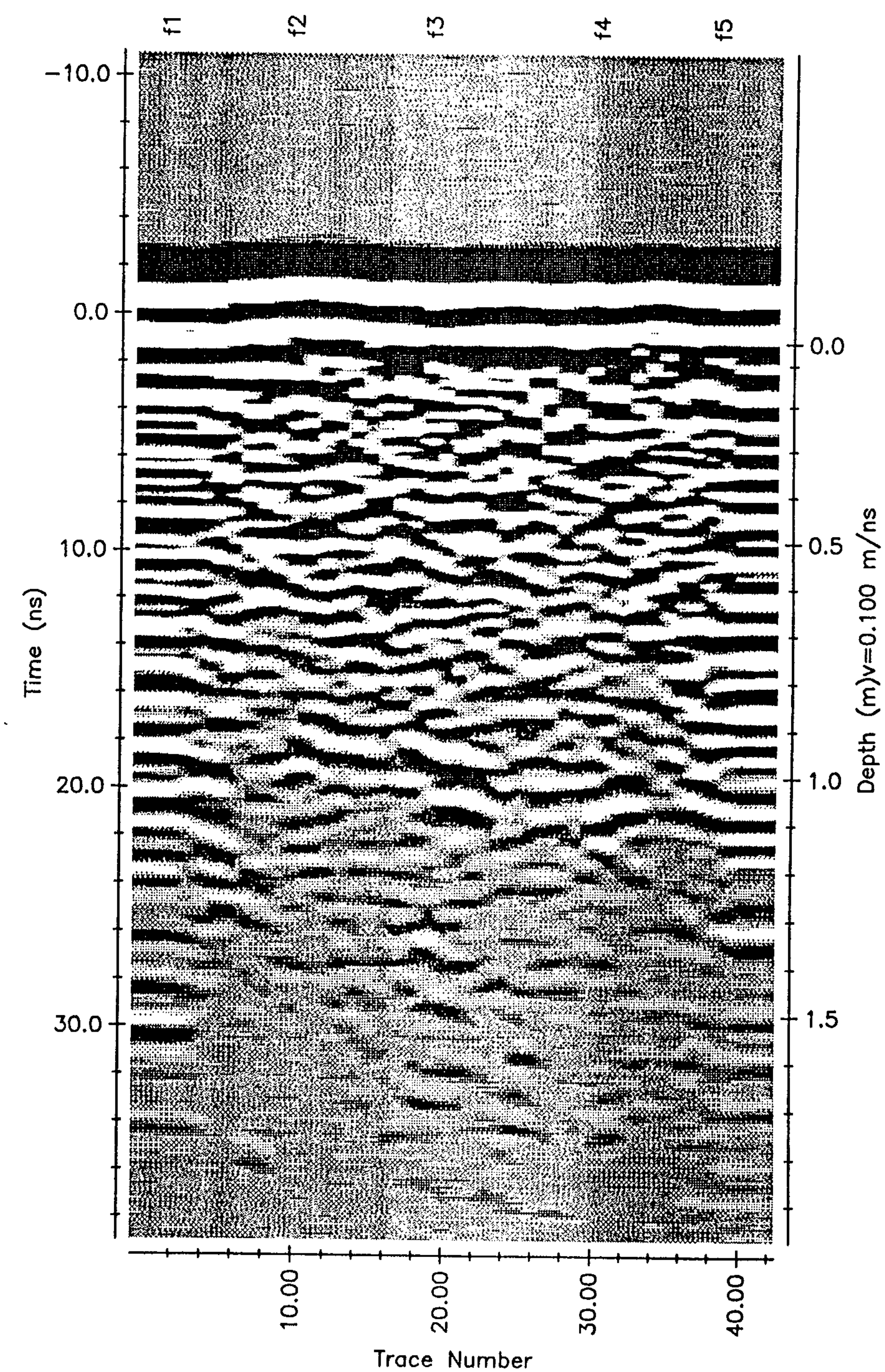
PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0700 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\20SEP0~1\CG900GP1
     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Crystal Gypsum Pile, 900 MHz, Pipe - North Edge of Pile
     DATE   = 20/09/10
     NUMBER OF TRACES      = 43
     NUMBER OF PTS/TRC     = 1000
     TIMEZERO AT POINT     = 220
     TOTAL TIME WINDOW     = 50
     STARTING POSITION     = 0.000
     FINAL POSITION        = 42.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 900.00
     ANTENNA SEPARATION    = 0.170
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 16
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971258/59

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 2
                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -11 to 39
                  POSITIONS: 0.000 to 42.000
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000


PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.1000 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

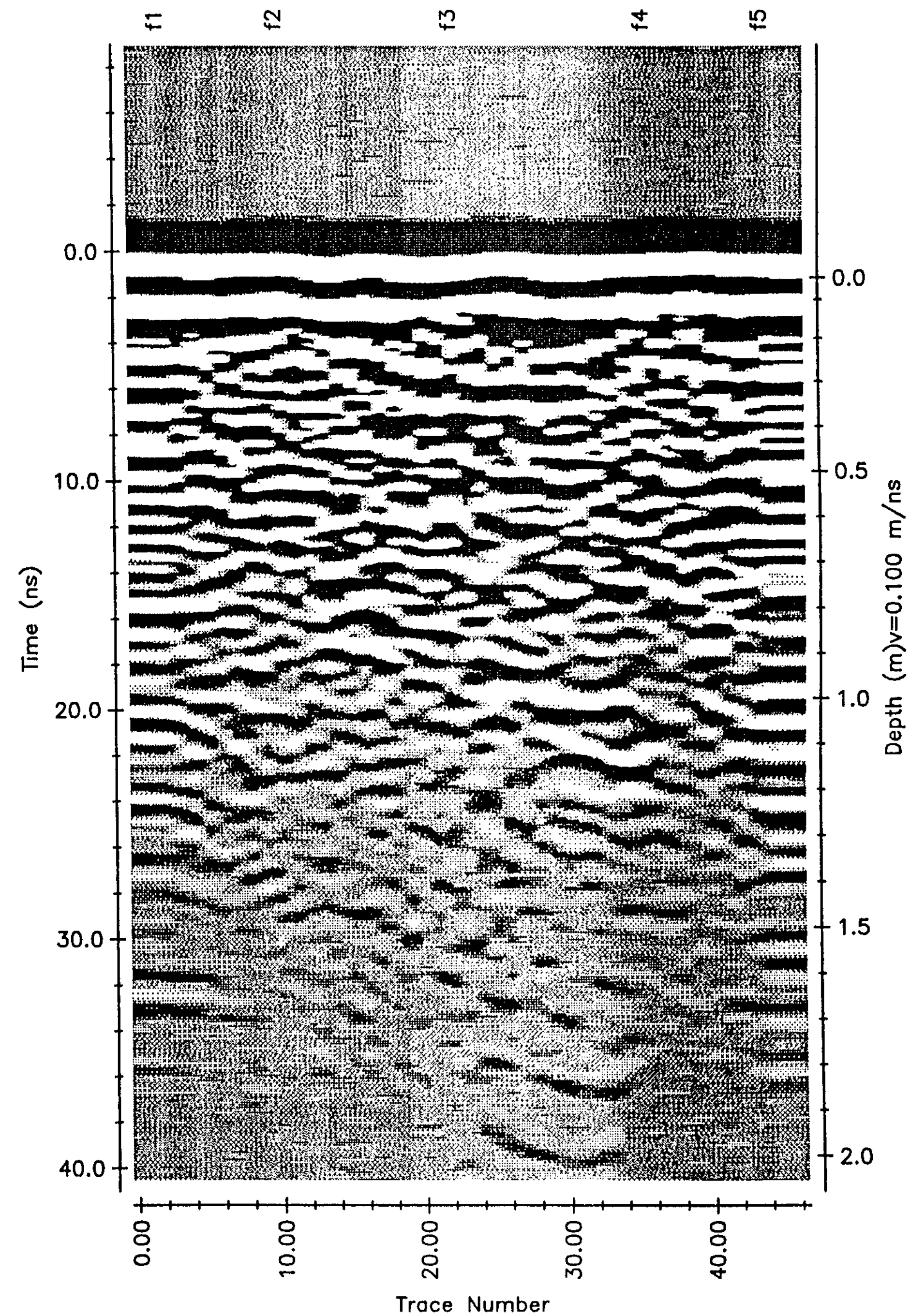
FILE = s:\COASTG~1\20SEP0~1\CG900GP2
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Crystal Gypsum Pile, 900 MHz, Pipe – Profile Over Pipe
DATE = 20/09/10
NUMBER OF TRACES = 47
NUMBER OF PTS/TRC = 1000
TIMEZERO AT POINT = 190
TOTAL TIME WINDOW = 50
STARTING POSITION = 0.000
FINAL POSITION = 46.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 900.00
ANTENNA SEPARATION = 0.170
PULSER VOLTAGE = 200
NUMBER OF STACKS = 16
SURVEY MODE = Reflection
COLLECTED BY PE1000 – CON: 981119 RX: 981120
TX: 981121 ANT: 971258/59

PROCESSING SELECTED

FILTERS: TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: –9 to 41
POSITIONS: 0.000 to 46.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS

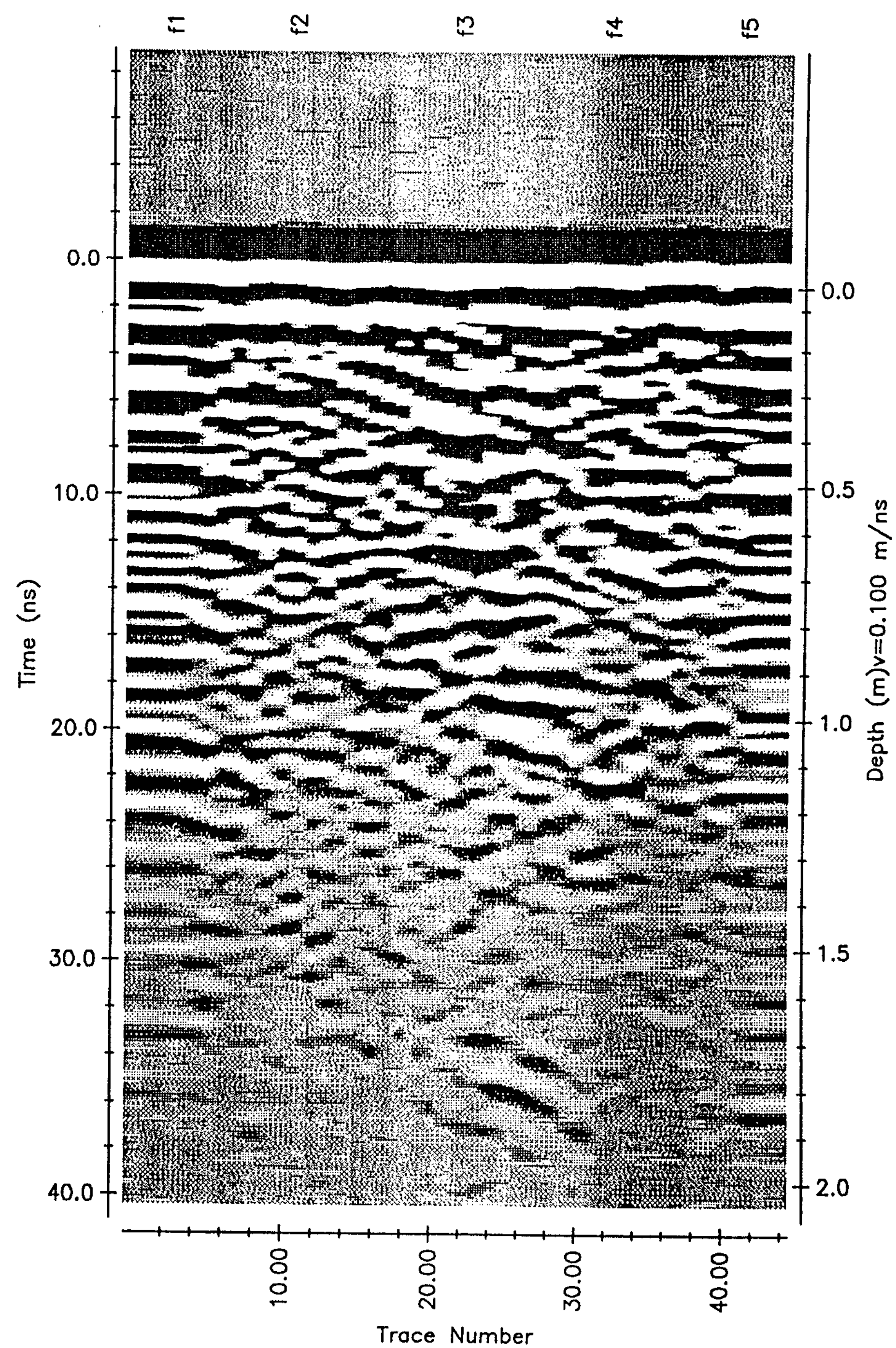
TRACE SPACING AND WIDTH: 0.1000 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: –0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\20SEP0~1\CG900GP3
     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Crystal Gypsum Pile, 900 MHz, Pipe - South Edge of Pipe
     DATE   = 20/09/10
     NUMBER OF TRACES      = 45
     NUMBER OF PTS/TRC     = 1000
     TIMEZERO AT POINT     = 192
     TOTAL TIME WINDOW     = 50
     STARTING POSITION     = 0.000
     FINAL POSITION        = 44.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 900.00
     ANTENNA SEPARATION    = 0.170
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 16
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971258/59

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 2
                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -9 to 41
                  POSITIONS: 0.000 to 44.000
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000


PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.1000 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

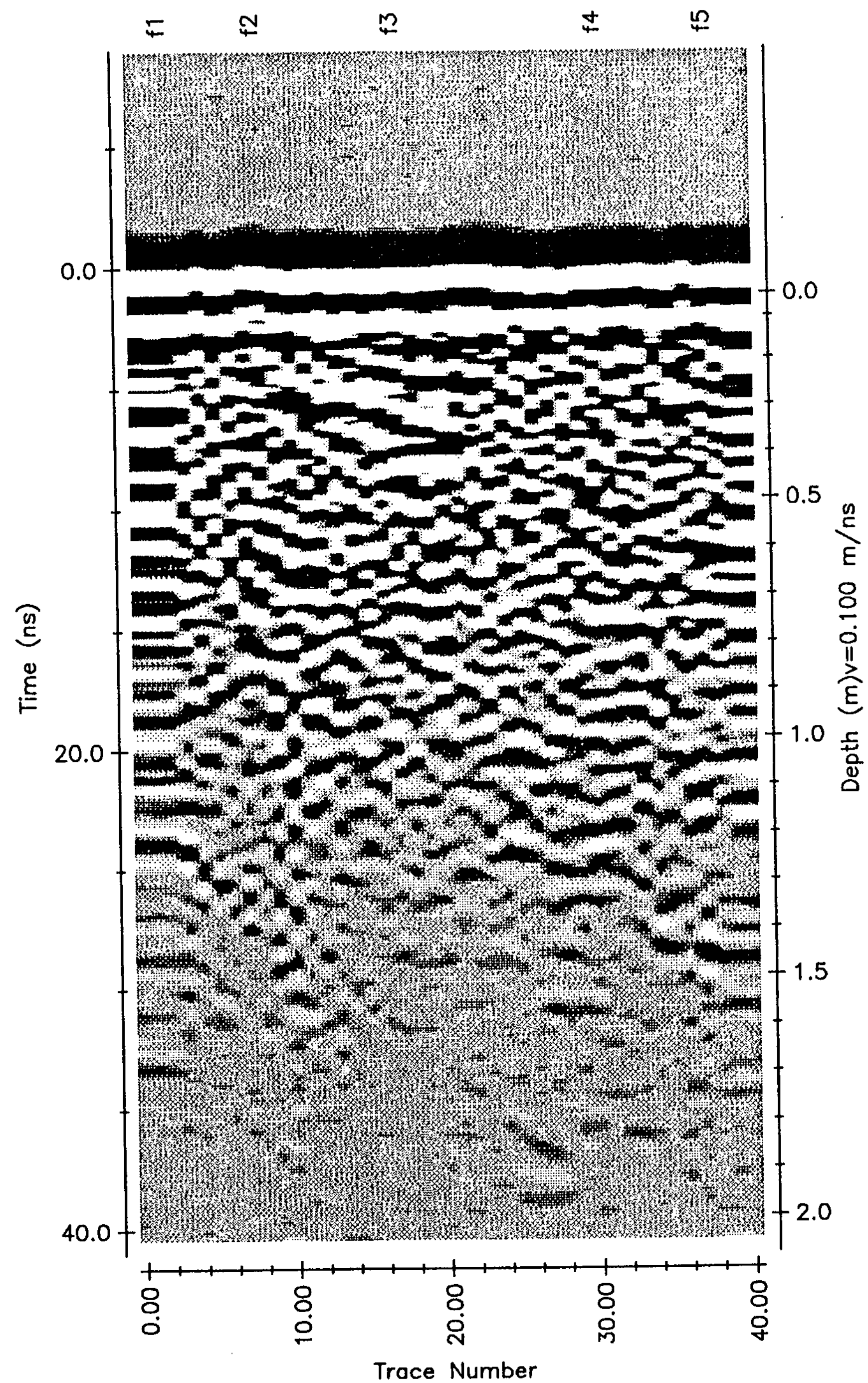
FILE	=	s:\COASTG~1\20SEP0~1\CG900GP4
JOB#	=	
TITLE	=	Alabama Shipyard, Bulk Handling Area
TITLE	=	Crystal Gypsum Pile, 900 MHz, Pipe – South Edge of Pile
DATE	=	20/09/10
NUMBER OF TRACES	=	41
NUMBER OF PTS/TRC	=	1000
TIMEZERO AT POINT	=	191
TOTAL TIME WINDOW	=	50
STARTING POSITION	=	0.000
FINAL POSITION	=	40.000
STEP SIZE USED	=	1.000
POSITION UNITS	=	metres
NOMINAL FREQUENCY	=	900.00
ANTENNA SEPARATION	=	0.170
PULSER VOLTAGE	=	200
NUMBER OF STACKS	=	16
SURVEY MODE	=	Reflection

COLLECTED BY PE1000 – CON: 981119 RX: 981120
TX: 981121 ANT: 971258/59

PROCESSING SELECTED

FILTERS:	TRACE STACKING: 1
	POINT STACKING: 5
	TRACE DIFFERENCING: N
	CORRECTION: DEWOW
SELECTION	TIME: –9 to 41
	POSITIONS: 0.000 to 40.000
GAINS:	GAIN TYPE: CONSTANT
	MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.1000 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: –0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS

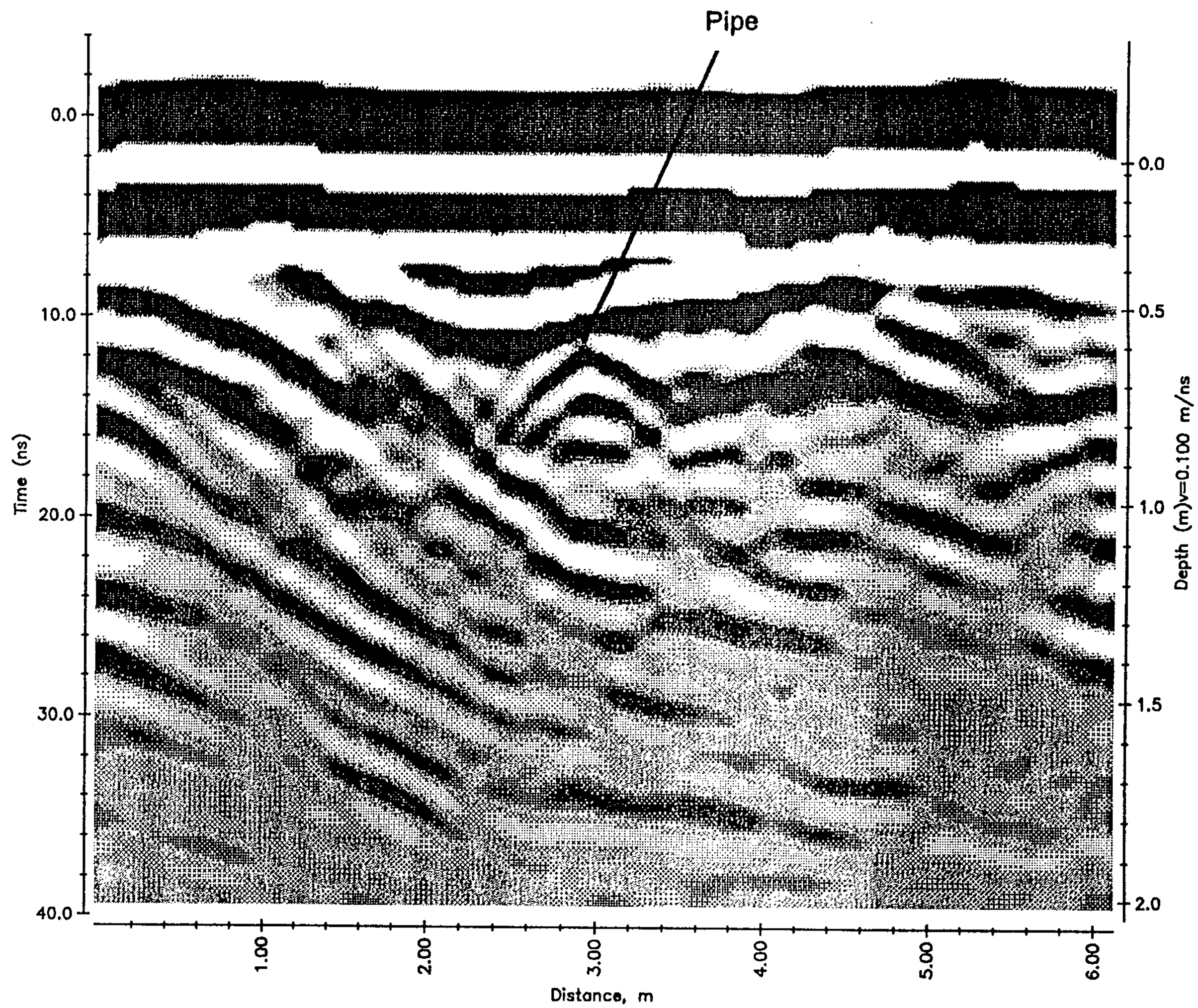
```
     FILE   = s:\COASTG~1\20SEP0~1\CG250GP0
     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Crystal Gypsum Pile, 250 MHz, Pipe - North Edge of Pile
     DATE   = 09/20/20
     NUMBER OF TRACES     = 123
     NUMBER OF PTS/TRC    = 111
     TIMEZERO AT POINT    = 11
     TOTAL TIME WINDOW    = 44
     STARTING POSITION    = 0.000
     FINAL POSITION       = 6.100
     STEP SIZE USED       = 0.050
     POSITION UNITS       = m
     NOMINAL FREQUENCY    = 250.00
     ANTENNA SEPARATION   = 0.305
     PULSER VOLTAGE       = 100
     NUMBER OF STACKS     = 16
     SURVEY MODE          = Reflection
```

PROCESSING SELECTED

```
     FILTERS:    TRACE STACKING: 2
                 POINT STACKING: 2
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
     SELECTION   TIME: -4 to 40
                 POSITIONS: 0.000 to 6.100
     GAINS:      GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

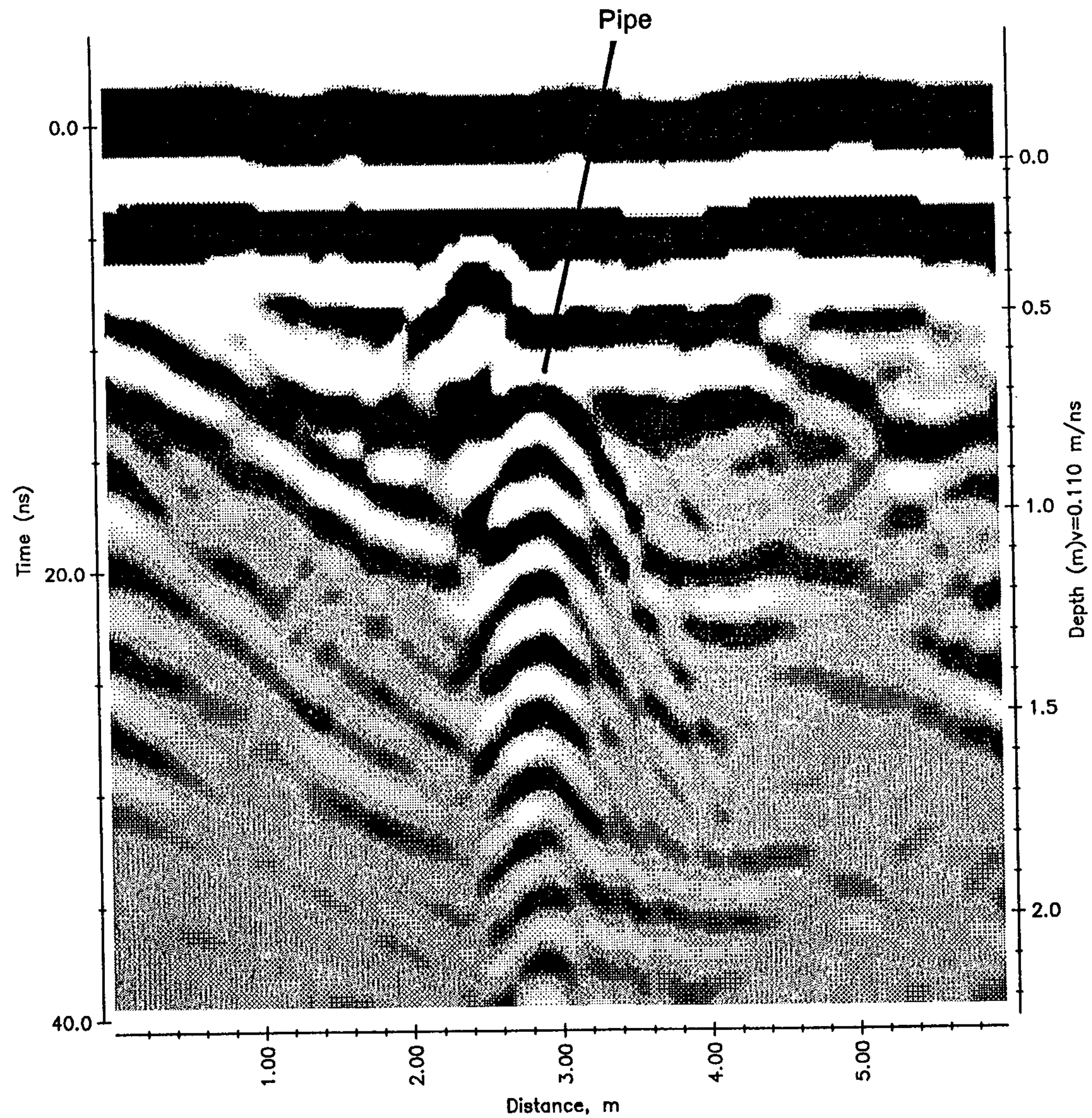
```
     TRACE SPACING AND WIDTH: 0.0750 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
    FILE   = s:\COASTG~1\20SEP0~1\CG250GP1
    JOB#   =
    TITLE  = Alabama Shipyard, Bulk Handling Area
    TITLE  = Crystal Gypsum Pile, 250 MHz, Pipe - Profile Over Pipe
    DATE   = 09/20/20
    NUMBER OF TRACES     = 120
    NUMBER OF PTS/TRC    = 111
    TIMEZERO AT POINT    = 11
    TOTAL TIME WINDOW    = 44
    STARTING POSITION    = 0.000
    FINAL POSITION       = 5.950
    STEP SIZE USED       = 0.050
    POSITION UNITS       = m
    NOMINAL FREQUENCY    = 250.00
    ANTENNA SEPARATION   = 0.305
    PULSER VOLTAGE       = 100
    NUMBER OF STACKS     = 16
    SURVEY MODE          = Reflection

PROCESSING SELECTED
    FILTERS:      TRACE STACKING: 1
                  POINT STACKING: 5
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
    SELECTION     TIME: -4 to 40
                  POSITIONS: 0.000 to 5.950
    GAINS:        GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000


PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.0600 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



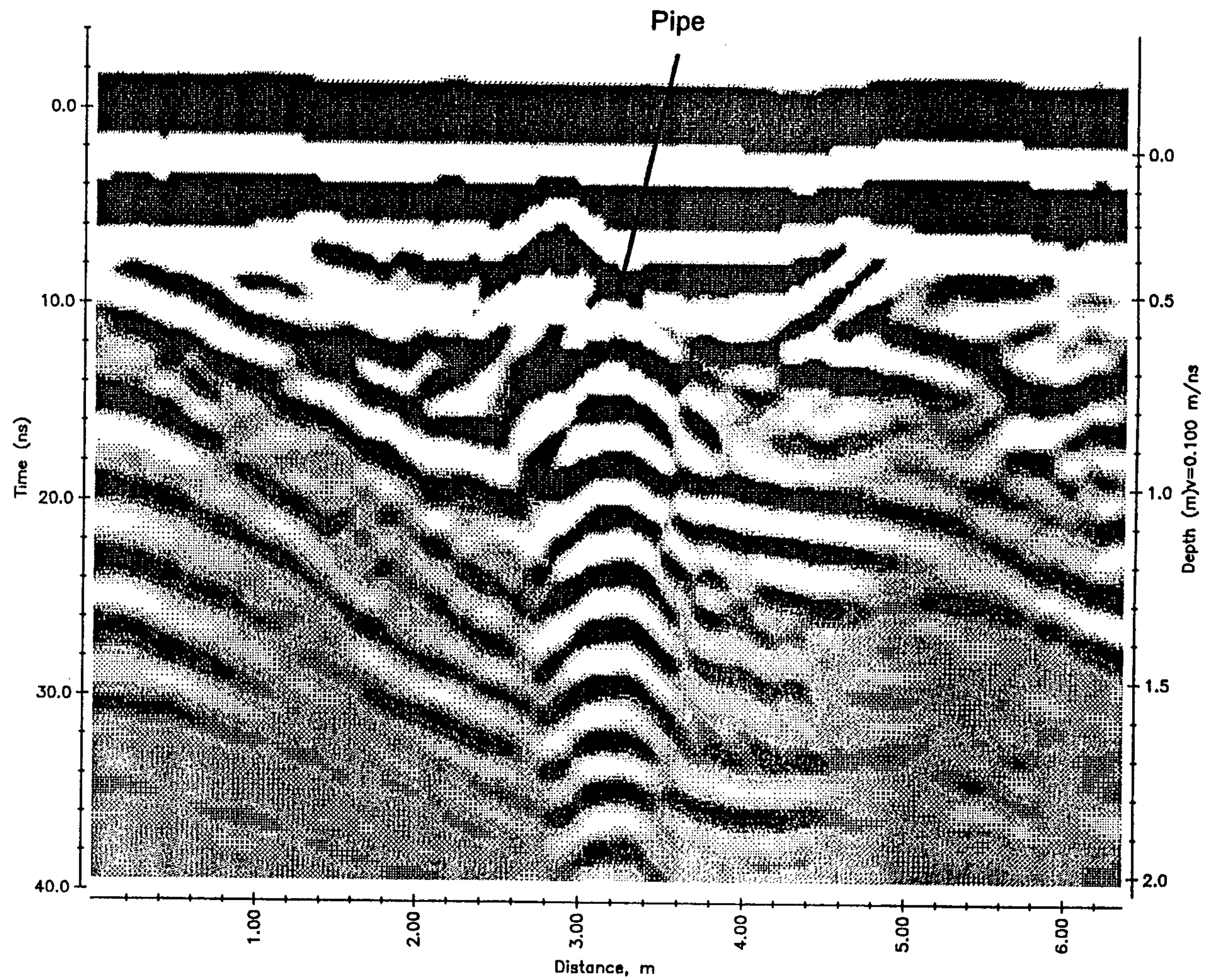
pulseEKKO HEADER PARAMETERS

FILE	=	s:\COASTG~1\20SEP0~1\CG250GP3
JOB#	=	
TITLE	=	Alabama Shipyard, Bulk Handling Area
TITLE	=	Crystal Gypsum Pile, 250 MHz, Pipe – South Edge of Pipe
DATE	=	09/20/20
NUMBER OF TRACES	=	128
NUMBER OF PTS/TRC	=	111
TIMEZERO AT POINT	=	11
TOTAL TIME WINDOW	=	44
STARTING POSITION	=	0.000
FINAL POSITION	=	6.350
STEP SIZE USED	=	0.050
POSITION UNITS	=	m
NOMINAL FREQUENCY	=	250.00
ANTENNA SEPARATION	=	0.305
PULSER VOLTAGE	=	100
NUMBER OF STACKS	=	16
SURVEY MODE	=	Reflection

PROCESSING SELECTED

FILTERS:	TRACE STACKING: 2
	POINT STACKING: 2
	TRACE DIFFERENCING: N
	CORRECTION: DEWOW
SELECTION	TIME: –4 to 40
	POSITIONS: 0.000 to 6.350
GAINS:	GAIN TYPE: CONSTANT
	MULTIPLIER: 100.000

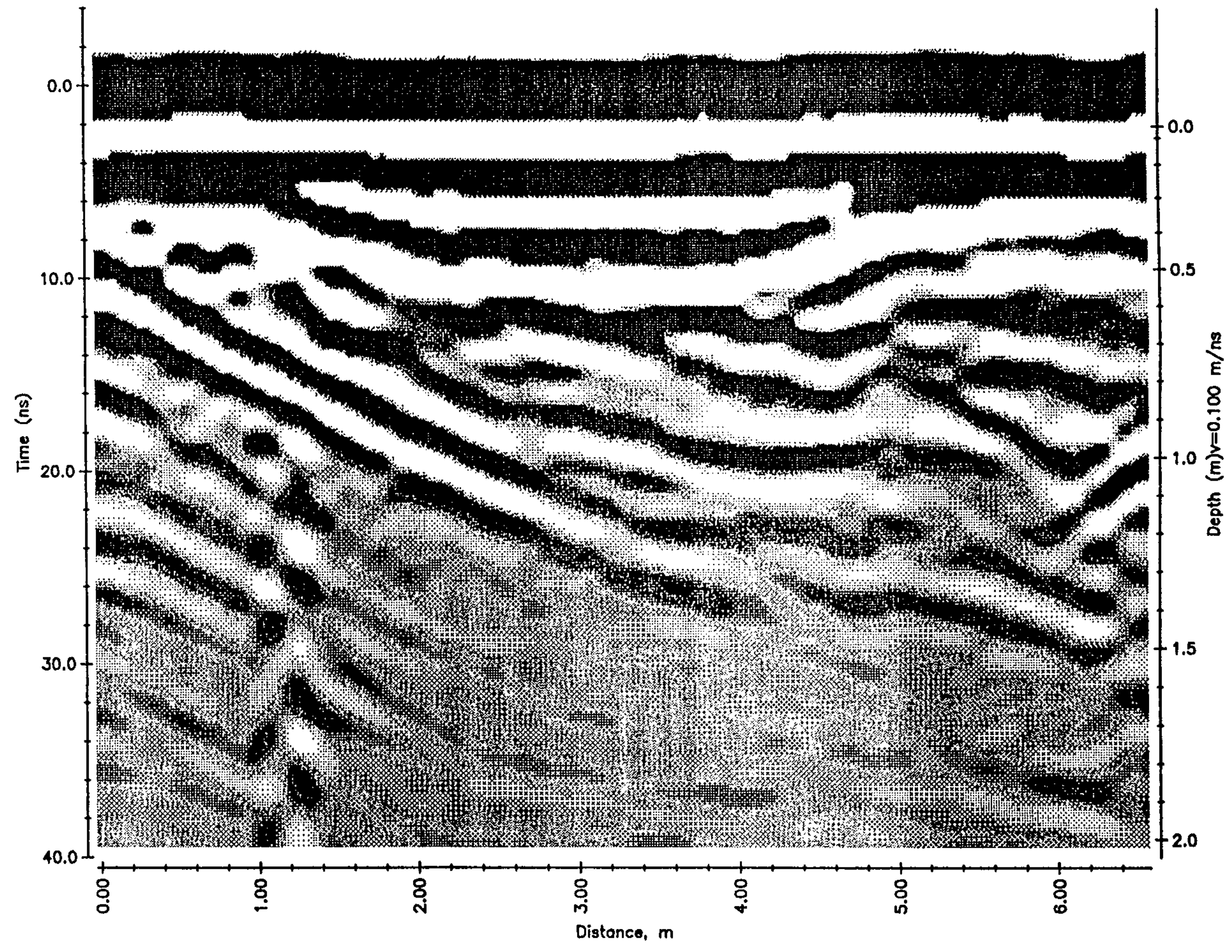
PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0750 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: –0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



```
pulseEKKO HEADER PARAMETERS
    FILE   = s:\COASTG~1\20SEP0~1\CG250GP5
    JOB#   =
    TITLE  = Alabama Shipyard, Bulk Handling Area
    TITLE  = Crystal Gypsum Pile, 250 MHz, Pipe - South Edge of Pile
    DATE   = 09/20/20
    NUMBER OF TRACES      = 132
    NUMBER OF PTS/TRC     = 111
    TIMEZERO AT POINT     = 11
    TOTAL TIME WINDOW     = 44
    STARTING POSITION     = 0.000
    FINAL POSITION        = 6.550
    STEP SIZE USED        = 0.050
    POSITION UNITS        = m
    NOMINAL FREQUENCY     = 250.00
    ANTENNA SEPARATION    = 0.305
    PULSER VOLTAGE        = 100
    NUMBER OF STACKS      = 16
    SURVEY MODE           = Reflection

PROCESSING SELECTED
    FILTERS:    TRACE STACKING: 2
                POINT STACKING: 2
                TRACE DIFFERENCING: N
                CORRECTION: DEWOW
    SELECTION   TIME: -4 to 40
                POSITIONS: 0.000 to 6.550
    GAINS:      GAIN TYPE: CONSTANT
                MULTIPLIER: 100.000


PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.0750 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```

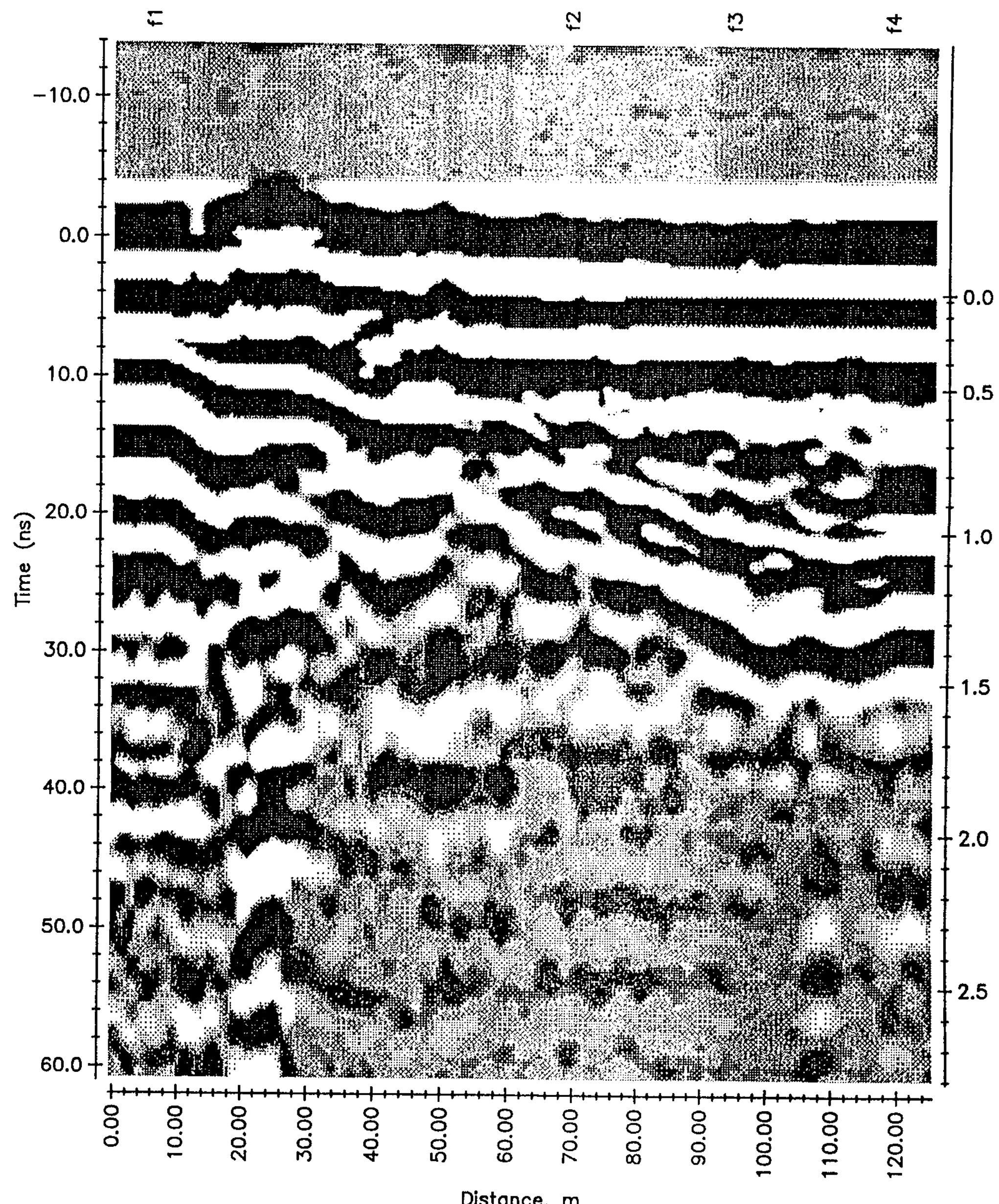


Appendix B
Powdered Gypsum
GPR Records - Initial Investigation

pulseEKKO HEADER PARAMETERS
FILE = s:\COASTG~1\20SEP0~1\CG225PP1
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Powdered Gypsum Pile, 225 MHz, Pipe – West Edge of Pile
DATE = 20/09/10
NUMBER OF TRACES = 126
NUMBER OF PTS/TRC = 250
TIMEZERO AT POINT = 47
TOTAL TIME WINDOW = 75
STARTING POSITION = 0.000
FINAL POSITION = 125.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 225.00
ANTENNA SEPARATION = 0.500
PULSER VOLTAGE = 200
NUMBER OF STACKS = 16
SURVEY MODE = Reflection
COLLECTED BY PE1000 – CON: 981119 RX: 981120
TX: 981121 ANT: 971195/96

PROCESSING SELECTED
FILTERS: TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: –14 to 61
POSITIONS: 0.000 to 125.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

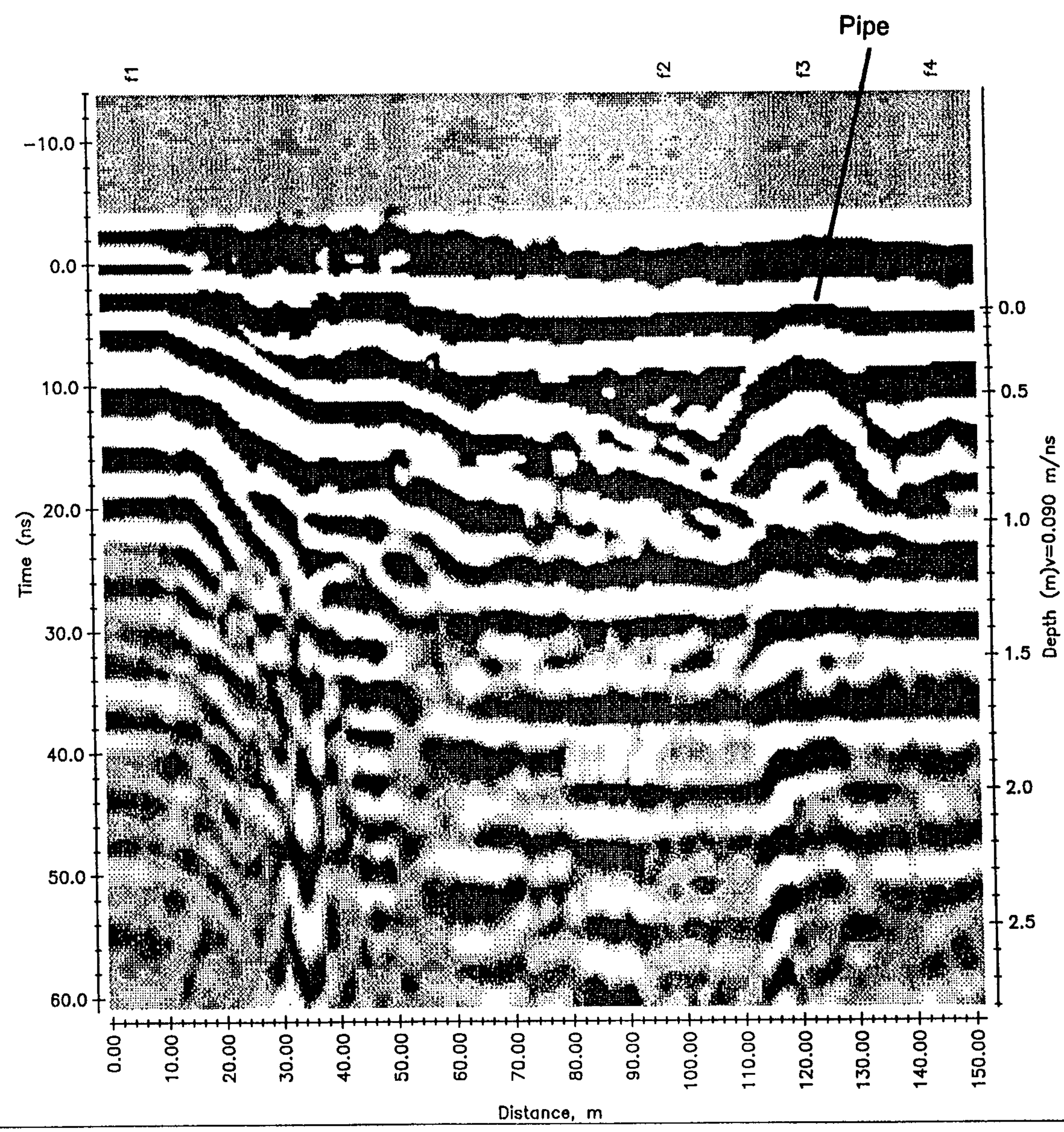
PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0500 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: –0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



```
pulseEKKO HEADER PARAMETERS
    FILE  = s:\COASTG~1\20SEP0~1\CG225PP2
    JOB#  =
    TITLE = Alabama Shipyard, Bulk Handling Area
    TITLE = Powdered Gypsum Pile, 225 MHz, Pipe - Profile Over Pipe
    DATE  = 20/09/10
    NUMBER OF TRACES     = 152
    NUMBER OF PTS/TRC    = 250
    TIMEZERO AT POINT    = 47
    TOTAL TIME WINDOW    = 75
    STARTING POSITION    = 0.000
    FINAL POSITION       = 151.000
    STEP SIZE USED       = 1.000
    POSITION UNITS       = metres
    NOMINAL FREQUENCY    = 225.00
    ANTENNA SEPARATION   = 0.500
    PULSER VOLTAGE       = 200
    NUMBER OF STACKS     = 16
    SURVEY MODE          = Reflection
    COLLECTED BY PE1000 - CON: 981119 RX: 981120
                          TX: 981121 ANT: 971195/96

PROCESSING SELECTED
    FILTERS:    TRACE STACKING: 2
                POINT STACKING: 2
                TRACE DIFFERENCING: N
                CORRECTION: DEWOW
    SELECTION   TIME: -14 to 61
                POSITIONS: 0.000 to 151.000
    GAINS:      GAIN TYPE: CONSTANT
                MULTIPLIER: 100.000

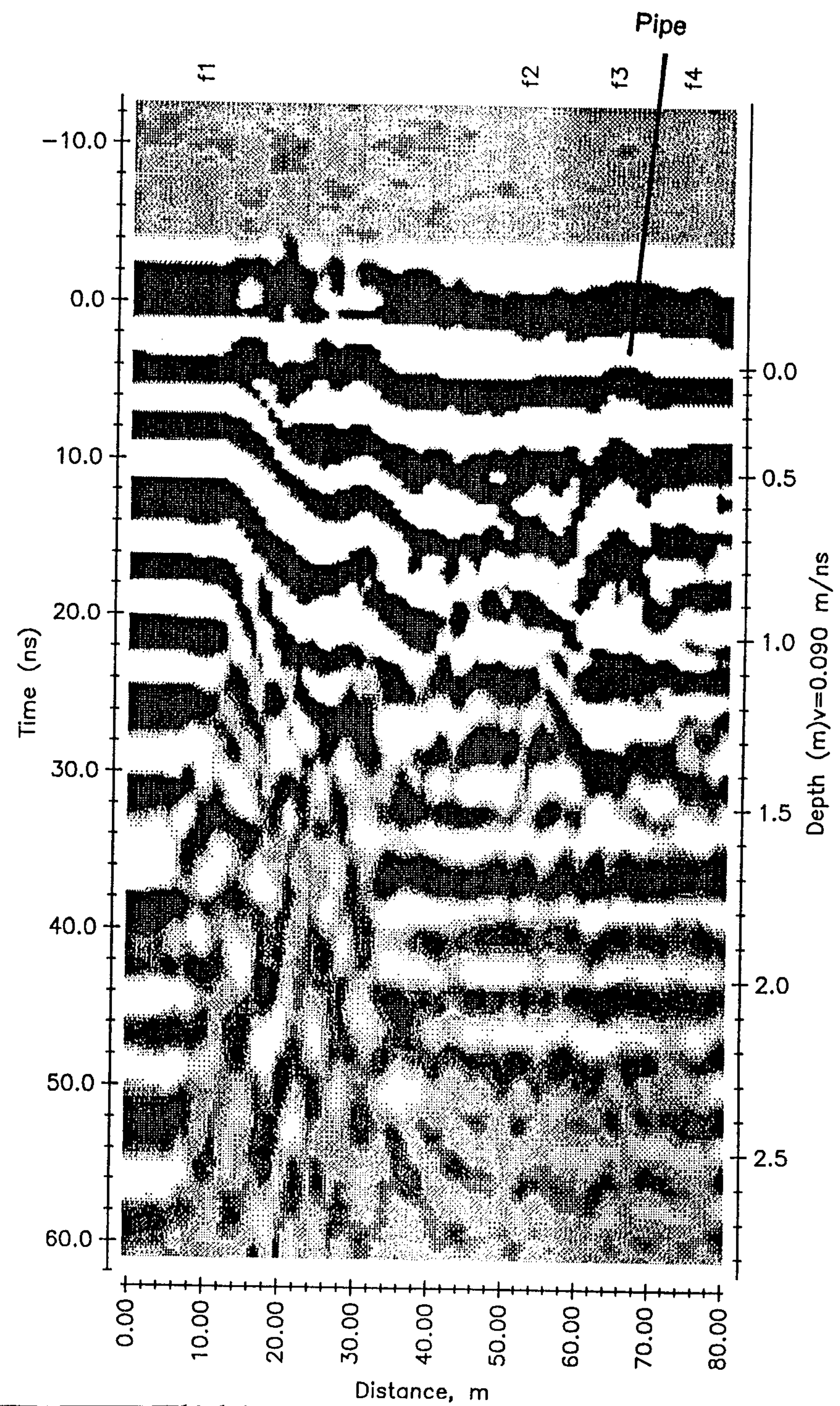
PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.0500 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\20SEP0~1\CG225PP3
     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Powdered Gypsum Pile, 225 MHz, Pipe - Profile Over Pipe
     DATE   = 20/09/10
     NUMBER OF TRACES     = 81
     NUMBER OF PTS/TRC    = 250
     TIMEZERO AT POINT    = 46
     TOTAL TIME WINDOW    = 75
     STARTING POSITION    = 0.000
     FINAL POSITION       = 80.000
     STEP SIZE USED       = 1.000
     POSITION UNITS       = metres
     NOMINAL FREQUENCY    = 225.00
     ANTENNA SEPARATION   = 0.500
     PULSER VOLTAGE       = 200
     NUMBER OF STACKS     = 16
     SURVEY MODE          = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971195/96

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 2
                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -13 to 62
                  POSITIONS: 0.000 to 80.000
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000

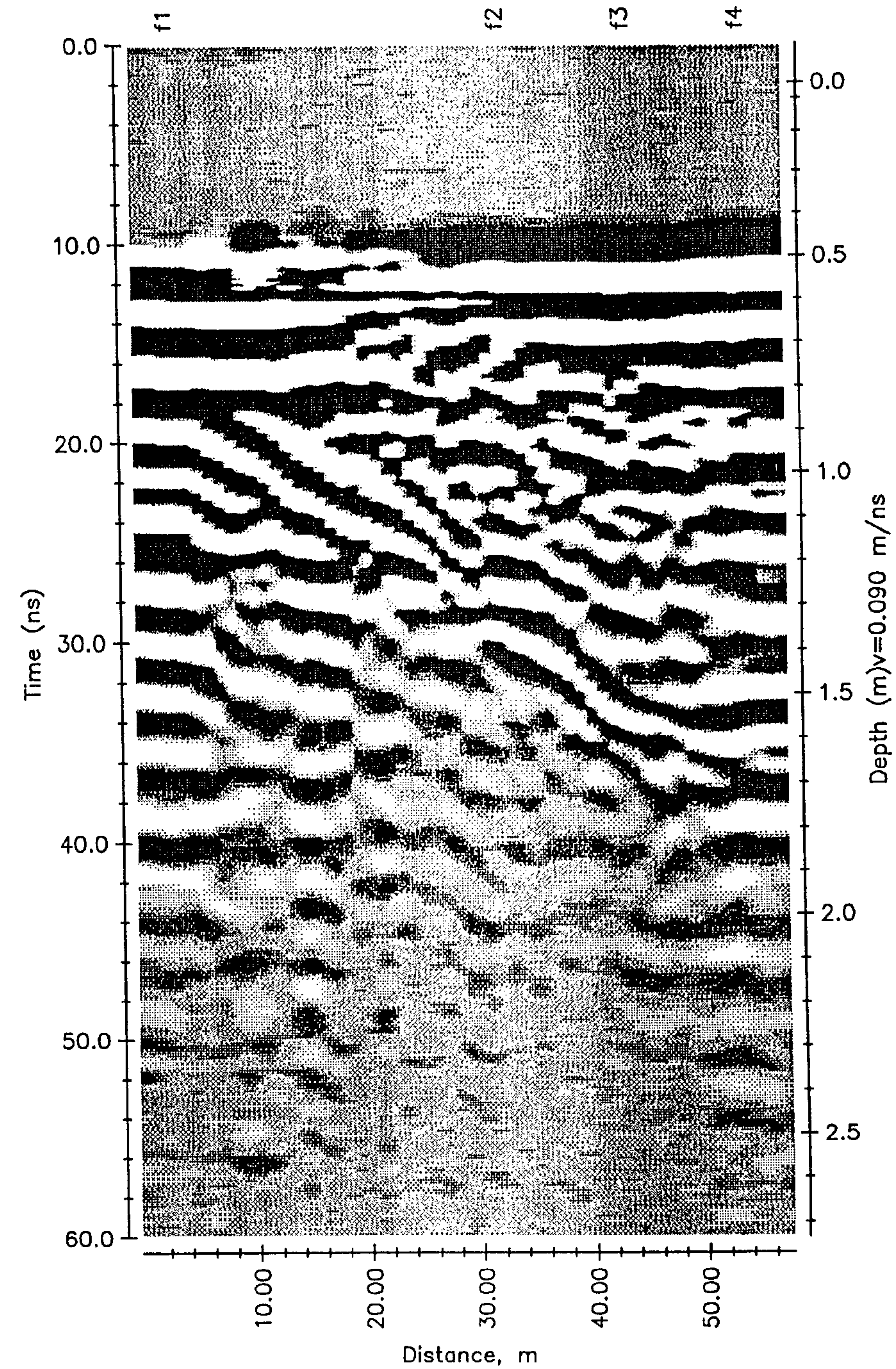

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0500 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
    FILE   = s:\COASTG~1\20SEP0~1\CG450PP1
    JOB#   =
    TITLE  = Alabama Shipyard, Bulk Handling Area
    TITLE  = Powdered Gypsum Pile, 450 MHz, Pipe - West Edge of Pile
    DATE   = 20/09/10
    NUMBER OF TRACES      = 58
    NUMBER OF PTS/TRC     = 600
    TIMEZERO AT POINT     = 1
    TOTAL TIME WINDOW     = 60
    STARTING POSITION     = 0.000
    FINAL POSITION        = 57.000
    STEP SIZE USED        = 1.000
    POSITION UNITS        = metres
    NOMINAL FREQUENCY     = 450.00
    ANTENNA SEPARATION    = 0.250
    PULSER VOLTAGE        = 200
    NUMBER OF STACKS      = 16
    SURVEY MODE           = Reflection
    COLLECTED BY PE1000 - CON: 981119 RX: 981120
                          TX: 981121 ANT: 971181/82

PROCESSING SELECTED
    FILTERS:     TRACE STACKING: 2
                 POINT STACKING: 2
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
    SELECTION    TIME: 0 to 60
                 POSITIONS: 0.000 to 57.000
    GAINS:       GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000

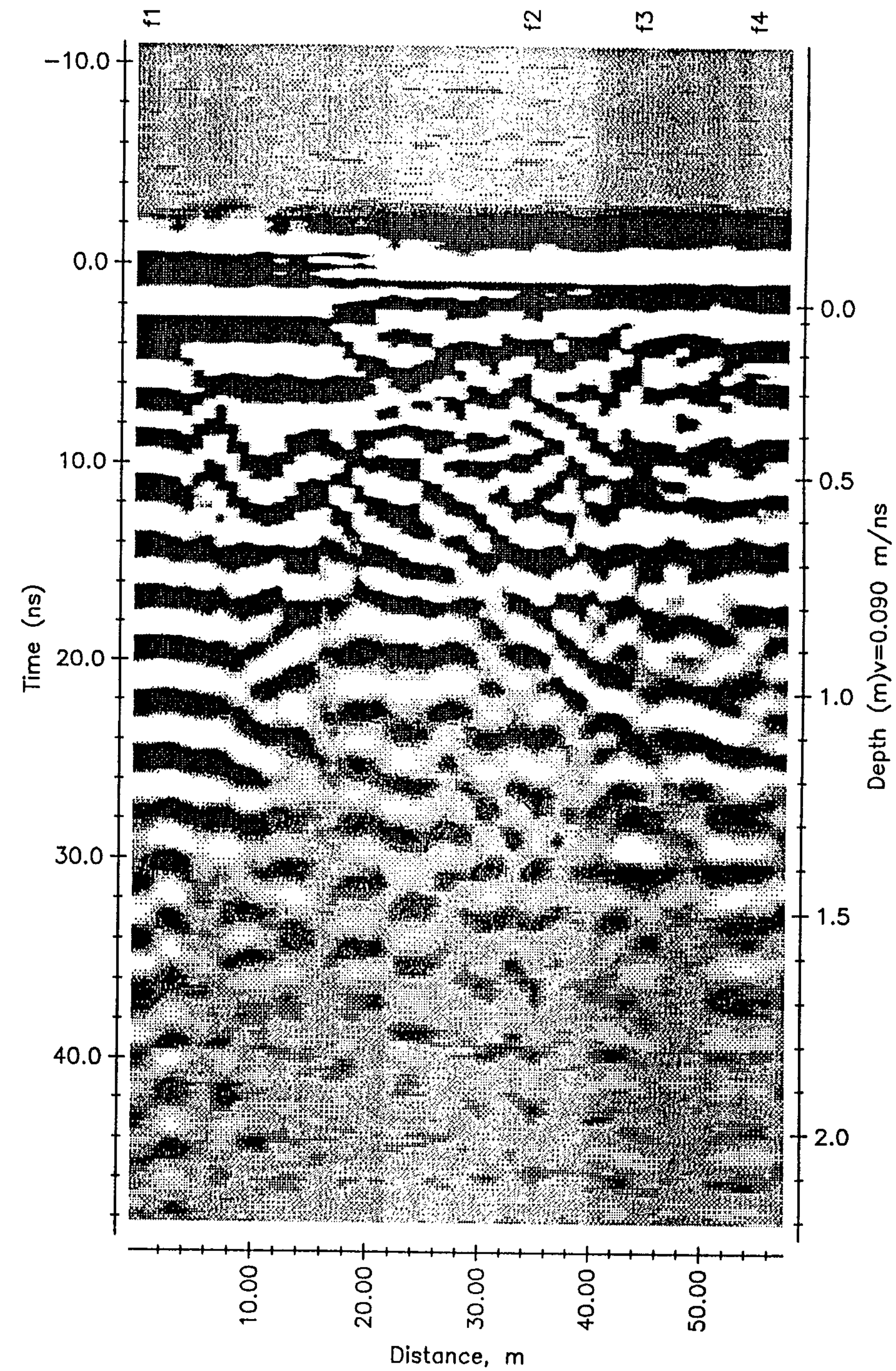
PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.0750 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\20SEP0~1\CG450PP2
     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Powdered Gypsum Pile, 450 MHz, Pipe - Profile Over Pipe
     DATE   = 20/09/10
     NUMBER OF TRACES      = 58
     NUMBER OF PTS/TRC     = 600
     TIMEZERO AT POINT     = 117
     TOTAL TIME WINDOW     = 60
     STARTING POSITION     = 0.000
     FINAL POSITION        = 57.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 450.00
     ANTENNA SEPARATION    = 0.250
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 16
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971181/82

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 2
                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -11 to 49
                  POSITIONS: 0.000 to 57.000
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000

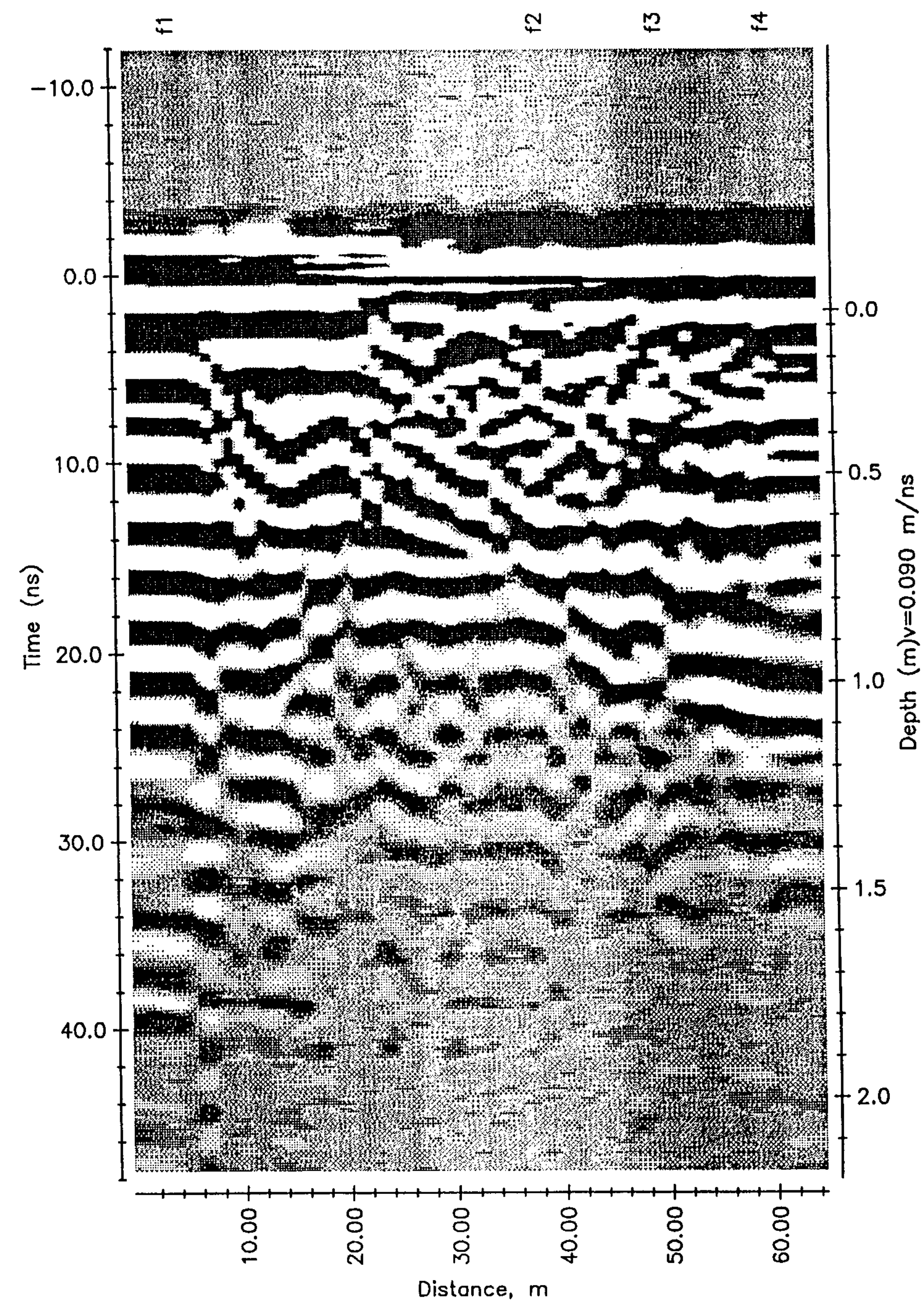

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0750 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
    FILE  = s:\COASTG~1\20SEP0~1\CG450PP3
    JOB# =
    TITLE  = Alabama Shipyard, Bulk Handling Area
    TITLE  = Powdered Gypsum Pile, 450 MHz, Pipe - Profile Over Pipe
    DATE  = 20/09/10
    NUMBER OF TRACES      = 65
    NUMBER OF PTS/TRC     = 600
    TIMEZERO AT POINT     = 124
    TOTAL TIME WINDOW     = 60
    STARTING POSITION     = 0.000
    FINAL POSITION        = 64.000
    STEP SIZE USED        = 1.000
    POSITION UNITS        = metres
    NOMINAL FREQUENCY     = 450.00
    ANTENNA SEPARATION    = 0.250
    PULSER VOLTAGE        = 200
    NUMBER OF STACKS      = 16
    SURVEY MODE           = Reflection
    COLLECTED BY PE1000 - CON: 981119 RX: 981120
                          TX: 981121 ANT: 971181/82

PROCESSING SELECTED
    FILTERS:     TRACE STACKING: 2
                 POINT STACKING: 2
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
    SELECTION    TIME: -12 to 48
                 POSITIONS: 0.000 to 64.000
    GAINS:       GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.0750 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

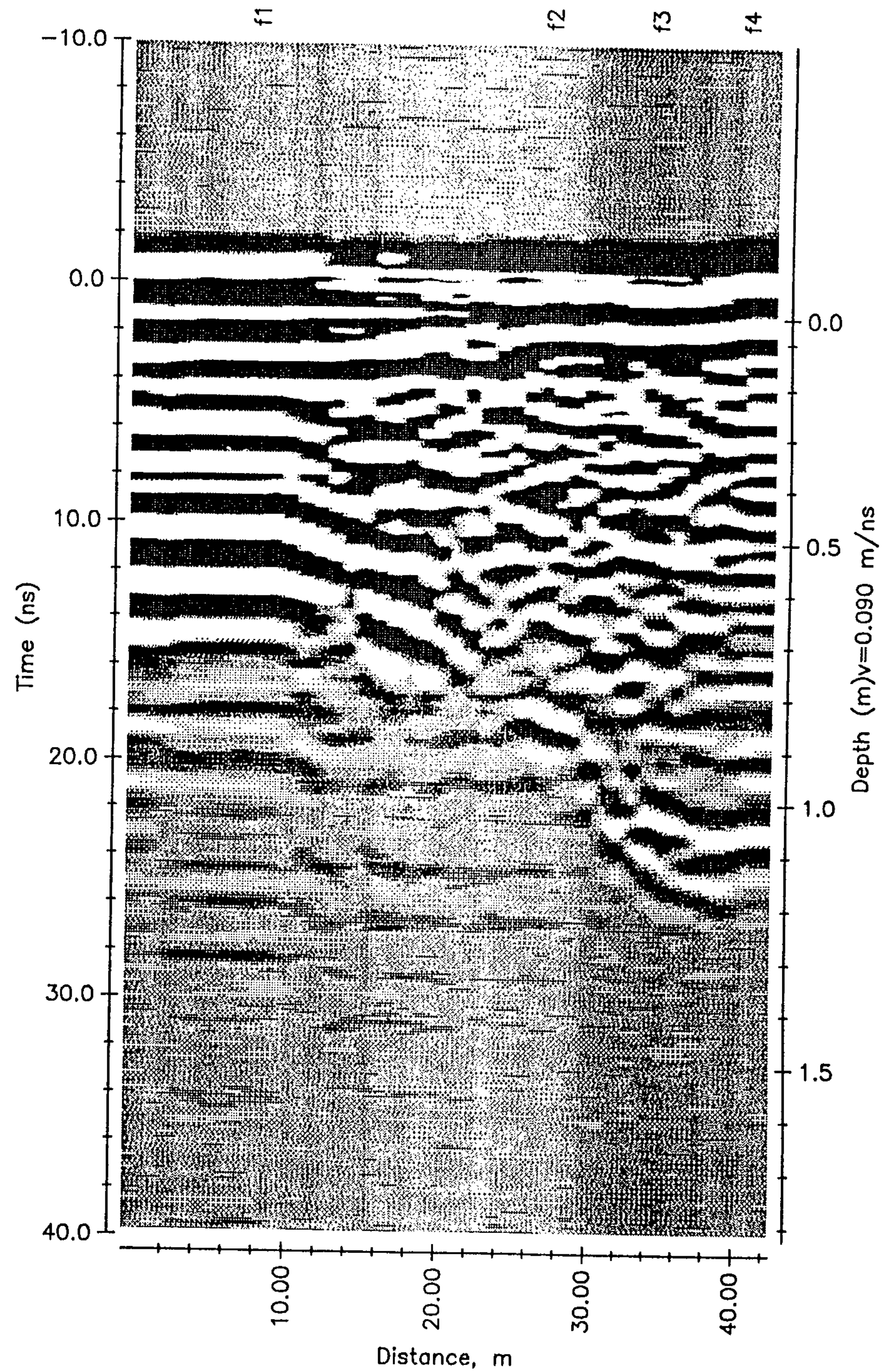
```
FILE   = s:\COASTG~1\20SEP0~1\CG900PP1
JOB#   =
TITLE  = Alabama Shipyard, Bulk Handling Area
TITLE  = Powdered Gypsum Pile, 900 MHz, Pipe - West Edge of Pile
DATE   = 20/09/10
NUMBER OF TRACES      = 43
NUMBER OF PTS/TRC     = 1000
TIMEZERO AT POINT     = 205
TOTAL TIME WINDOW     = 50
STARTING POSITION     = 0.000
FINAL POSITION        = 42.000
STEP SIZE USED        = 1.000
POSITION UNITS        = metres
NOMINAL FREQUENCY     = 900.00
ANTENNA SEPARATION    = 0.170
PULSER VOLTAGE        = 200
NUMBER OF STACKS      = 16
SURVEY MODE           = Reflection
COLLECTED BY PE1000 - CON: 981119 RX: 981120
                      TX: 981121 ANT: 971258/59
```

PROCESSING SELECTED

```
FILTERS:    TRACE STACKING: 2
            POINT STACKING: 2
            TRACE DIFFERENCING: N
            CORRECTION: DEWOW
SELECTION   TIME: -10 to 40
            POSITIONS: 0.000 to 42.000
GAINS:      GAIN TYPE: CONSTANT
            MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

```
TRACE SPACING AND WIDTH: 0.1000 and 0.2500
TRACE BOTTOM AND TOP: 1.0000  and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

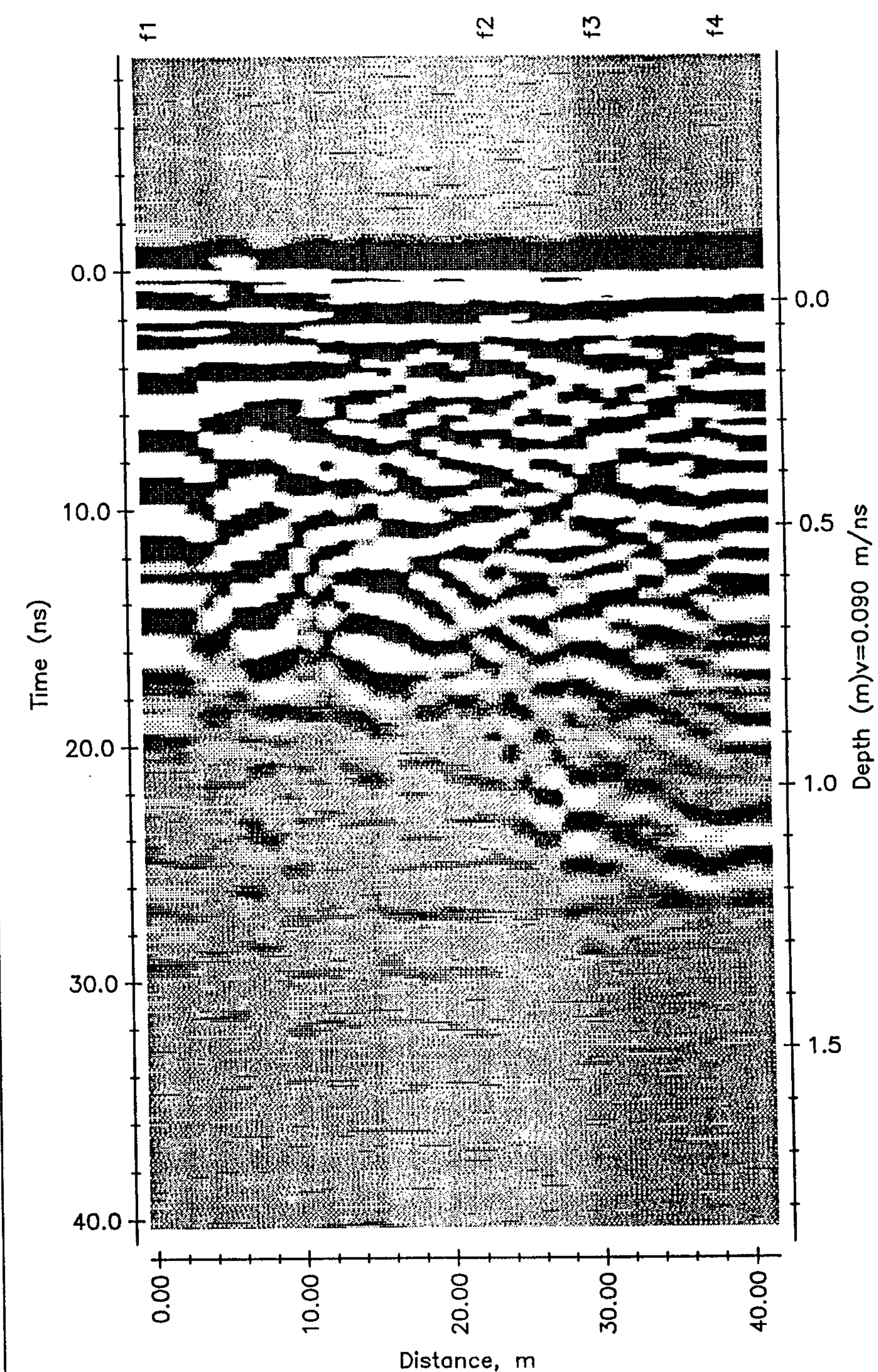
```
    FILE   = s:\COASTG~1\20SEP0~1\CG900PP2
    JOB#   =
    TITLE  = Alabama Shipyard, Bulk Handling Area
    TITLE  = Powdered Gypsum Pile, 900 MHz, Pipe - Profile Over Pipe
    DATE   = 20/09/10
    NUMBER OF TRACES     = 42
    NUMBER OF PTS/TRC    = 1000
    TIMEZERO AT POINT    = 193
    TOTAL TIME WINDOW    = 50
    STARTING POSITION    = 0.000
    FINAL POSITION       = 41.000
    STEP SIZE USED       = 1.000
    POSITION UNITS       = metres
    NOMINAL FREQUENCY    = 900.00
    ANTENNA SEPARATION   = 0.170
    PULSER VOLTAGE       = 200
    NUMBER OF STACKS     = 16
    SURVEY MODE          = Reflection
    COLLECTED BY PE1000 - CON: 981119 RX: 981120
                          TX: 981121 ANT: 971258/59
```

PROCESSING SELECTED

```
    FILTERS:     TRACE STACKING: 2
                 POINT STACKING: 2
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
    SELECTION    TIME: -9 to 41
                 POSITIONS: 0.000 to 41.000
    GAINS:       GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

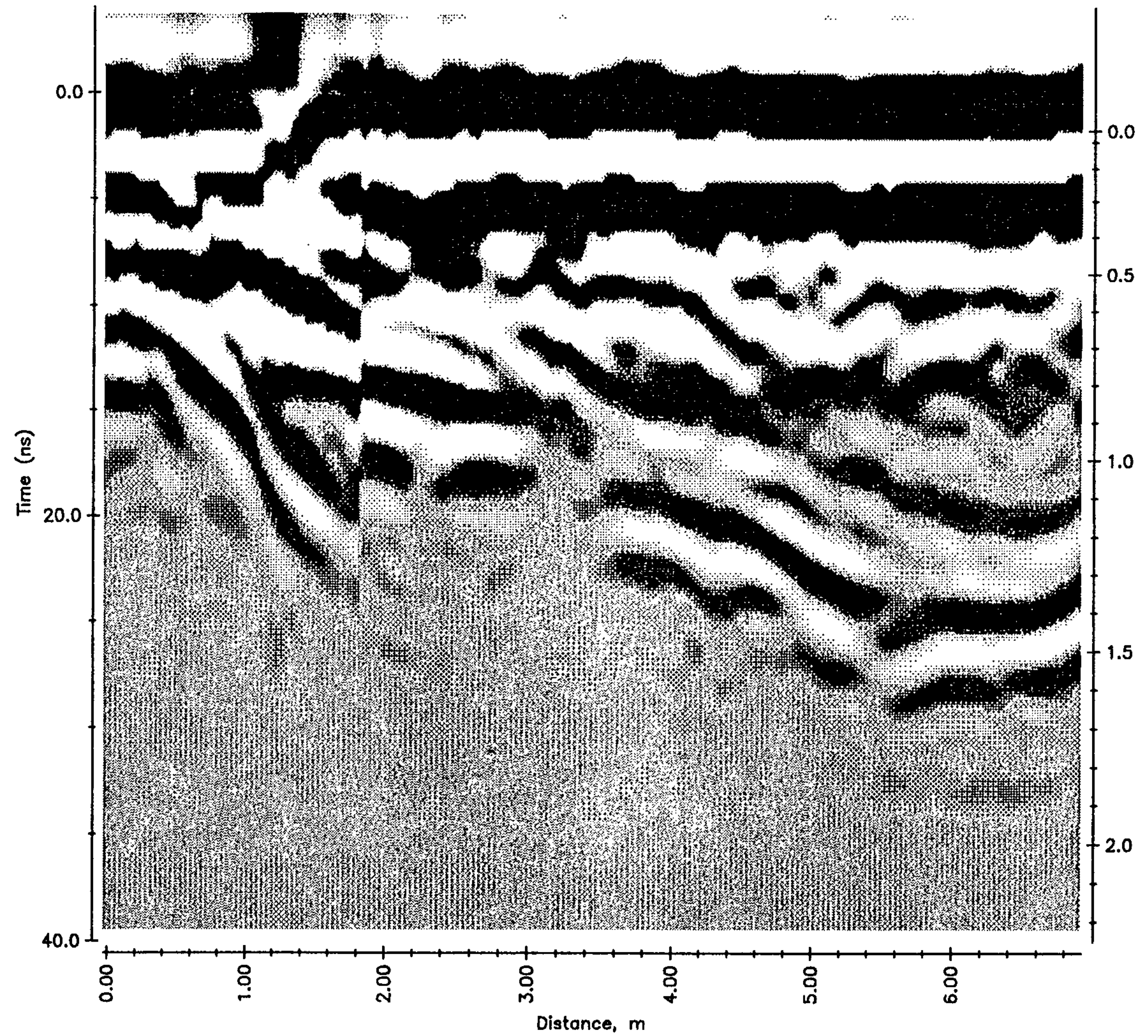
```
    TRACE SPACING AND WIDTH: 0.1000 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\20SEP0~1\CG250PP0
     JOB#  =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Powered Gypsum Pile, 250 MHz, Pipe - West Edge of Pile
     DATE   = 09/20/20
     NUMBER OF TRACES      = 139
     NUMBER OF PTS/TRC     = 111
     TIMEZERO AT POINT     = 11
     TOTAL TIME WINDOW     = 44
     STARTING POSITION     = 0.000
     FINAL POSITION        = 6.900
     STEP SIZE USED        = 0.050
     POSITION UNITS        = m
     NOMINAL FREQUENCY     = 250.00
     ANTENNA SEPARATION    = 0.305
     PULSER VOLTAGE        = 100
     NUMBER OF STACKS      = 16
     SURVEY MODE           = Reflection

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 1
                  POINT STACKING: 5
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -4 to 40
                  POSITIONS: 0.000 to 6.900
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000

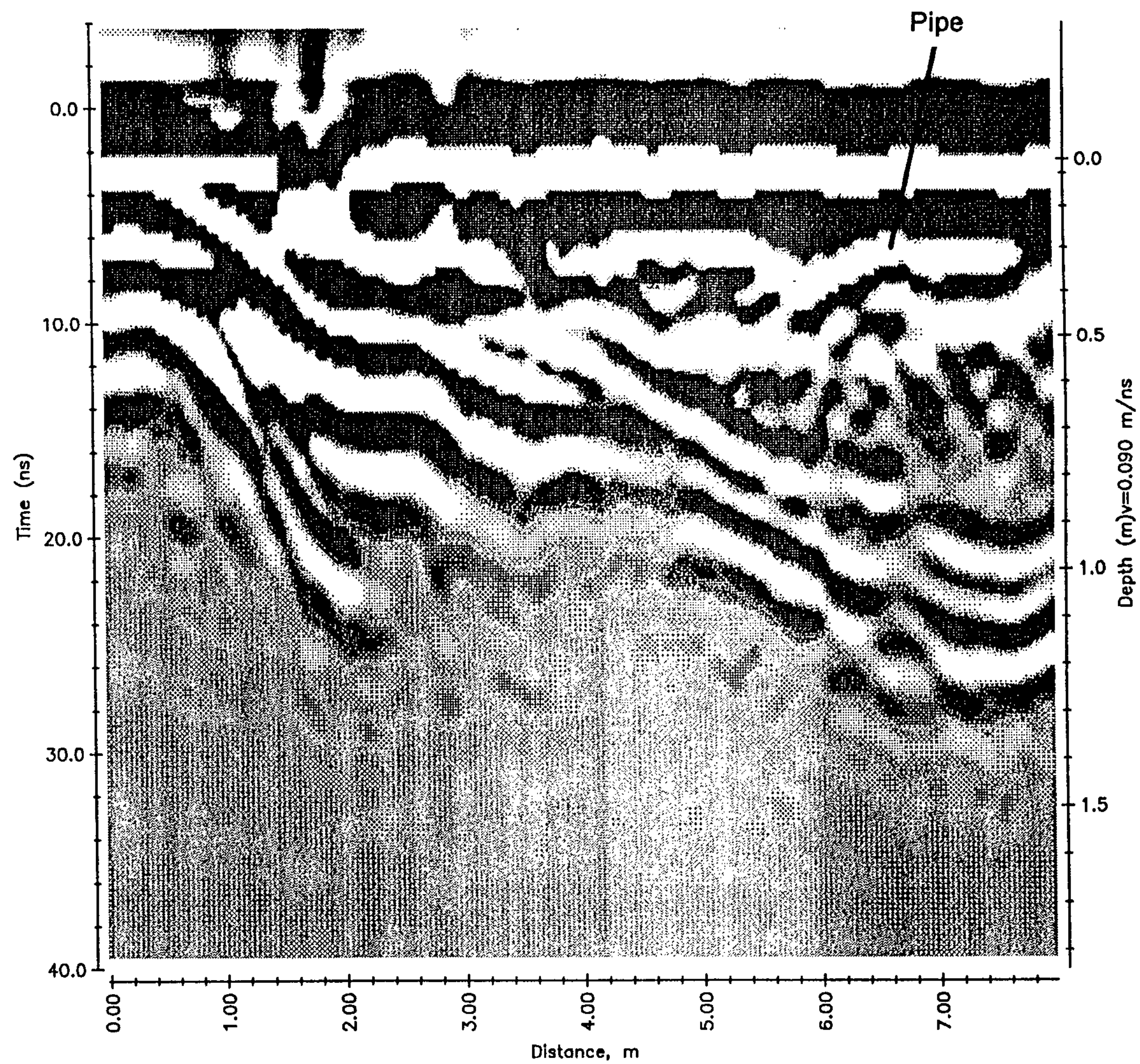
PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0600 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\20SEP0~1\CG250PP1
     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Powdered Gypsum Pile, 250 MHz, Pipe - West Edge of Pipe
     DATE   = 09/20/20
     NUMBER OF TRACES      = 160
     NUMBER OF PTS/TRC     = 111
     TIMEZERO AT POINT     = 11
     TOTAL TIME WINDOW     = 44
     STARTING POSITION     = 0.000
     FINAL POSITION        = 7.950
     STEP SIZE USED        = 0.050
     POSITION UNITS        = m
     NOMINAL FREQUENCY     = 250.00
     ANTENNA SEPARATION    = 0.305
     PULSER VOLTAGE        = 100
     NUMBER OF STACKS      = 16
     SURVEY MODE           = Reflection

PROCESSING SELECTED
     FILTERS:    TRACE STACKING: 2
                 POINT STACKING: 2
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
     SELECTION   TIME: -4 to 40
                 POSITIONS: 0.000 to 7.950
     GAINS:      GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0500 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

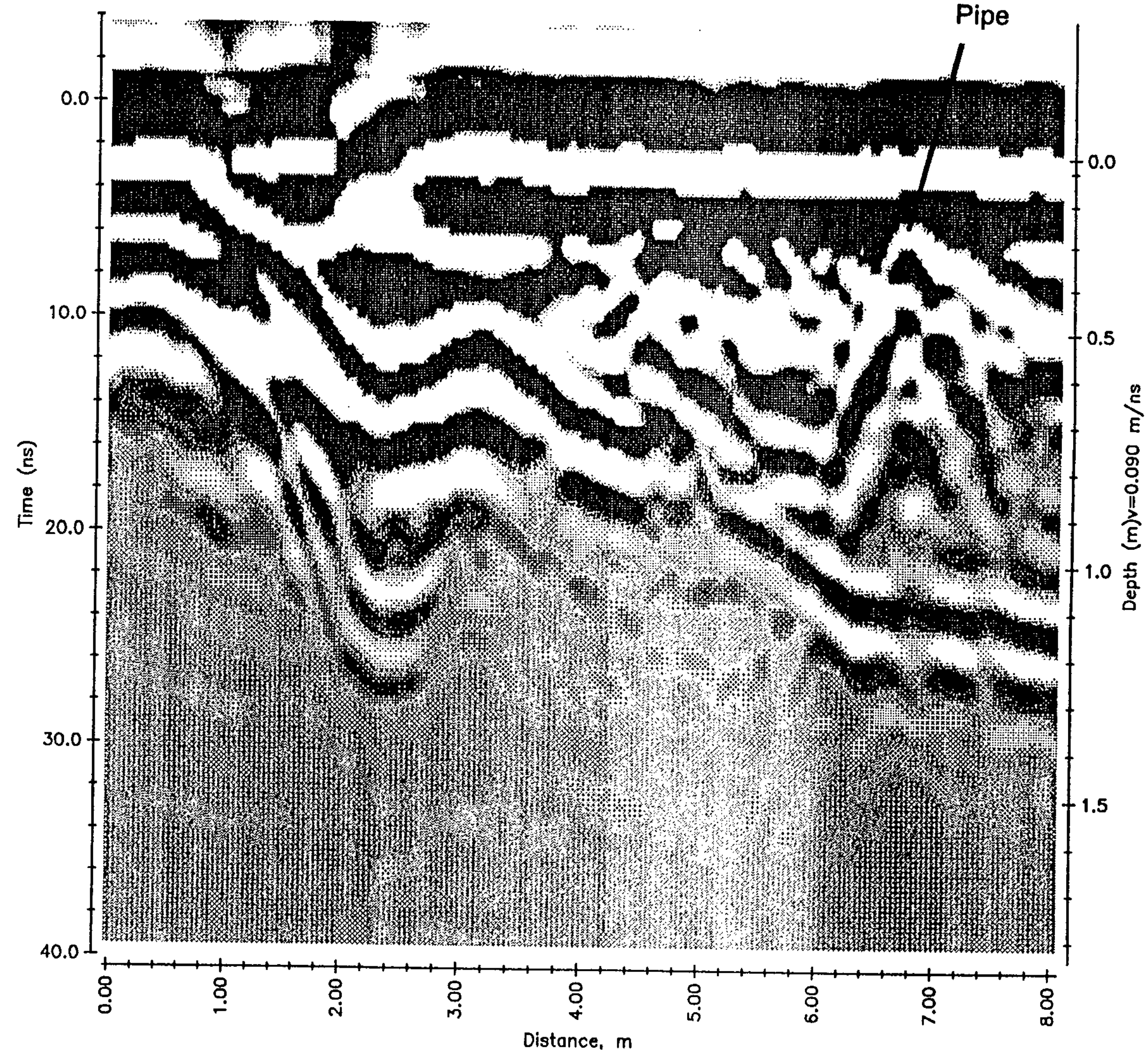
FILE = s:\COASTG~1\20SEP0~1\CG250PP2
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Powdered Gypsum Pile, 250 MHz, Pipe – Profile Over Pipe
DATE = 09/20/20
NUMBER OF TRACES = 162
NUMBER OF PTS/TRC = 111
TIMEZERO AT POINT = 11
TOTAL TIME WINDOW = 44
STARTING POSITION = 0.000
FINAL POSITION = 8.050
STEP SIZE USED = 0.050
POSITION UNITS = m
NOMINAL FREQUENCY = 250.00
ANTENNA SEPARATION = 0.305
PULSER VOLTAGE = 100
NUMBER OF STACKS = 16
SURVEY MODE = Reflection

PROCESSING SELECTED

FILTERS: TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: –4 to 40
POSITIONS: 0.000 to 8.050
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS

TRACE SPACING AND WIDTH: 0.0500 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: –0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS

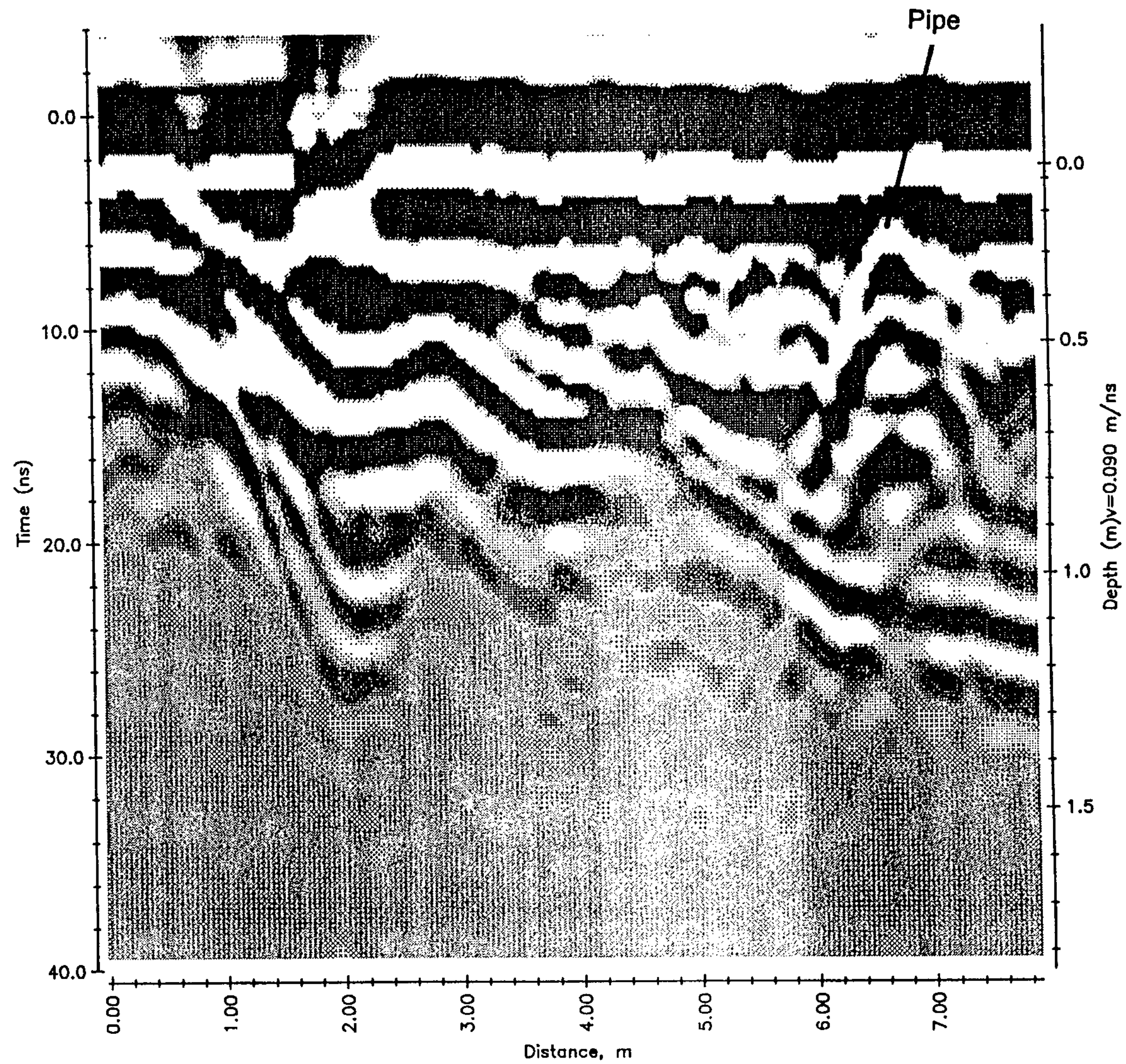
```
FILE  = s:\COASTG~1\20SEP0~1\CG250PP3
JOB#  =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Powdered Gypsum Pile, 250 MHz, Pipe - Profile Over Pipe
DATE  = 09/20/20
NUMBER OF TRACES      = 158
NUMBER OF PTS/TRC     = 111
TIMEZERO AT POINT     = 11
TOTAL TIME WINDOW     = 44
STARTING POSITION     = 0.000
FINAL POSITION        = 7.850
STEP SIZE USED        = 0.050
POSITION UNITS        = m
NOMINAL FREQUENCY     = 250.00
ANTENNA SEPARATION    = 0.305
PULSER VOLTAGE        = 100
NUMBER OF STACKS      = 16
SURVEY MODE           = Reflection
```

PROCESSING SELECTED

```
FILTERS:    TRACE STACKING: 2
            POINT STACKING: 2
            TRACE DIFFERENCING: N
            CORRECTION: DEWOW
SELECTION   TIME: -4 to 40
            POSITIONS: 0.000 to 7.850
GAINS:      GAIN TYPE: CONSTANT
            MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

```
TRACE SPACING AND WIDTH: 0.0500 and 0.2500
TRACE BOTTOM AND TOP: 1.0000  and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```

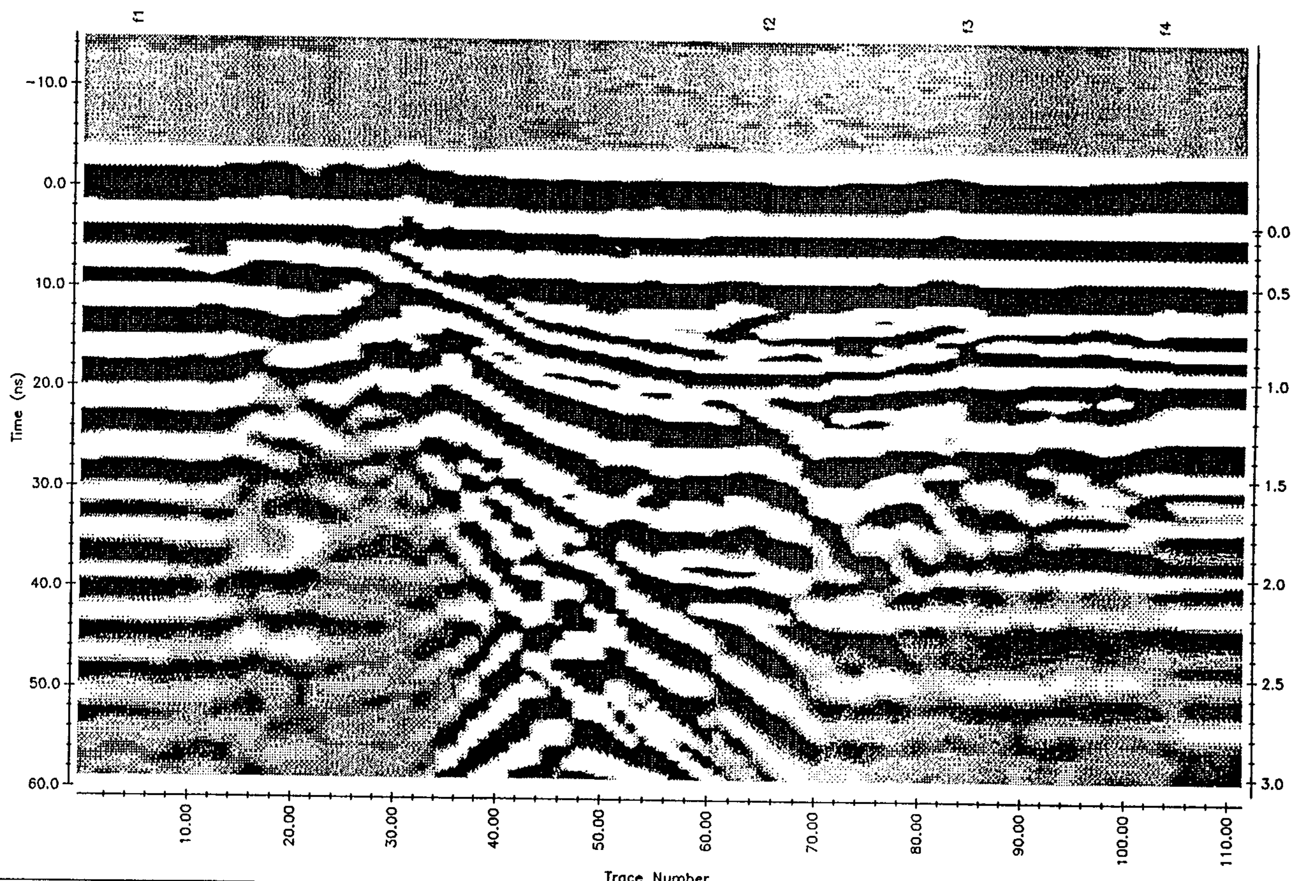


Appendix C
Crushed Pumice
GPR Records - Initial Investigation

pulseEKKO HEADER PARAMETERS
FILE = s:\COASTG~1\20SEP0~1\CG225MP1
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Pumice Pile, 225 MHz, Pipe – West Edge of Pile
DATE = 20/09/10
NUMBER OF TRACES = 112
NUMBER OF PTS/TRC = 250
TIMEZERO AT POINT = 53
TOTAL TIME WINDOW = 75
STARTING POSITION = 0.000
FINAL POSITION = 111.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 225.00
ANTENNA SEPARATION = 0.500
PULSER VOLTAGE = 200
NUMBER OF STACKS = 16
SURVEY MODE = Reflection
COLLECTED BY PE1000 – CON: 981119 RX: 981120
TX: 981121 ANT: 971195/96

PROCESSING SELECTED
FILTERS: TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: –15 to 60
POSITIONS: 0.000 to 111.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.1100 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: –0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

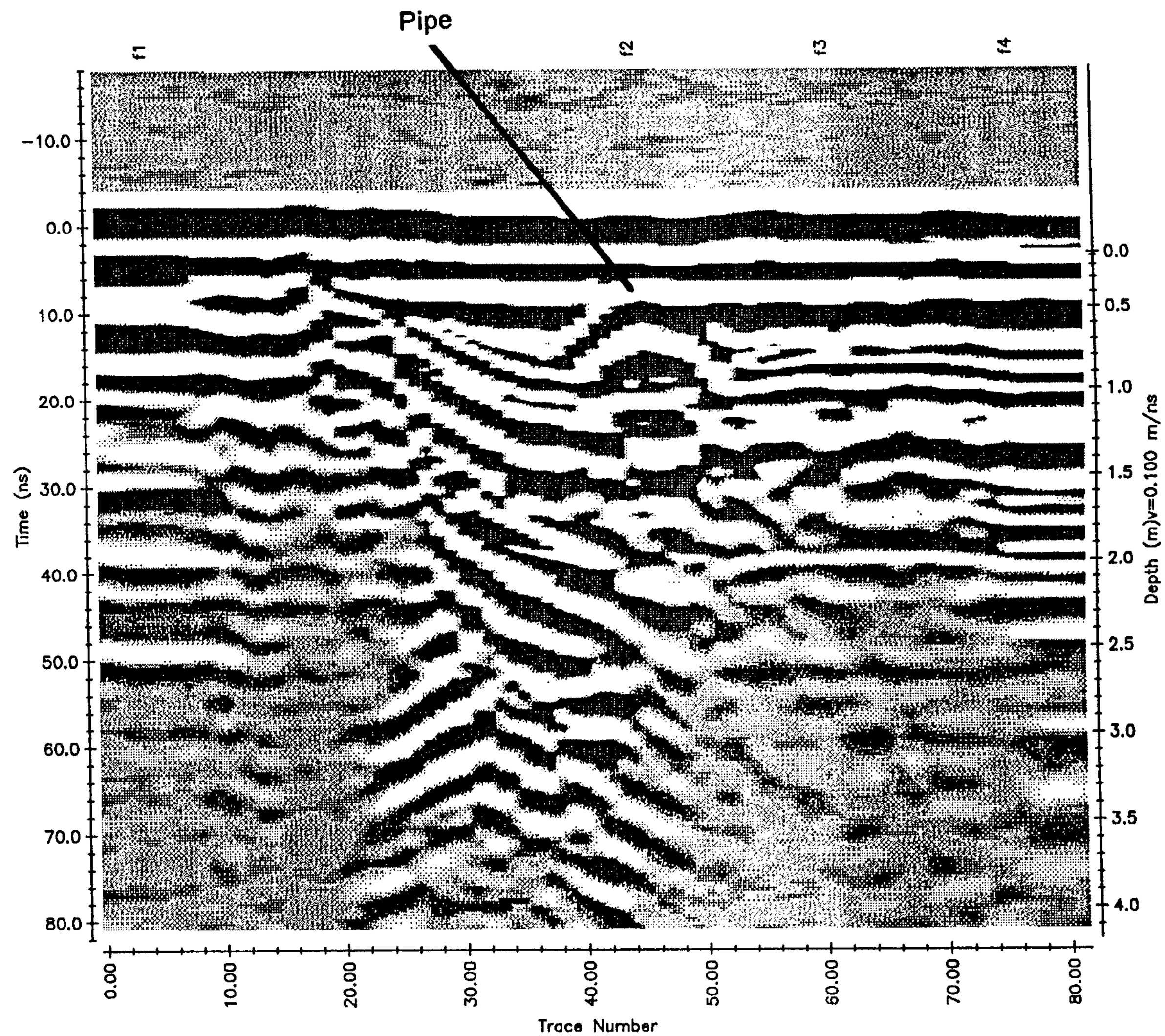


pulseEKKO HEADER PARAMETERS

```
     FILE   = s:\COASTG~1\20SEP0~1\CG225MP2
     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Pumice Pile, 225 MHz, Pipe - Profile Over Pipe
     DATE   = 20/09/10
     NUMBER OF TRACES      = 82
     NUMBER OF PTS/TRC     = 333
     TIMEZERO AT POINT     = 63
     TOTAL TIME WINDOW     = 100
     STARTING POSITION     = 0.000
     FINAL POSITION        = 81.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 225.00
     ANTENNA SEPARATION    = 0.500
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 16
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971195/96

PROCESSING SELECTED
     FILTERS:       TRACE STACKING: 2
                    POINT STACKING: 2
                    TRACE DIFFERENCING: N
                    CORRECTION: DEWOW
     SELECTION      TIME: -18 to 82
                    POSITIONS: 0.000 to 81.000
     GAINS:         GAIN TYPE: CONSTANT
                    MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.1100 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

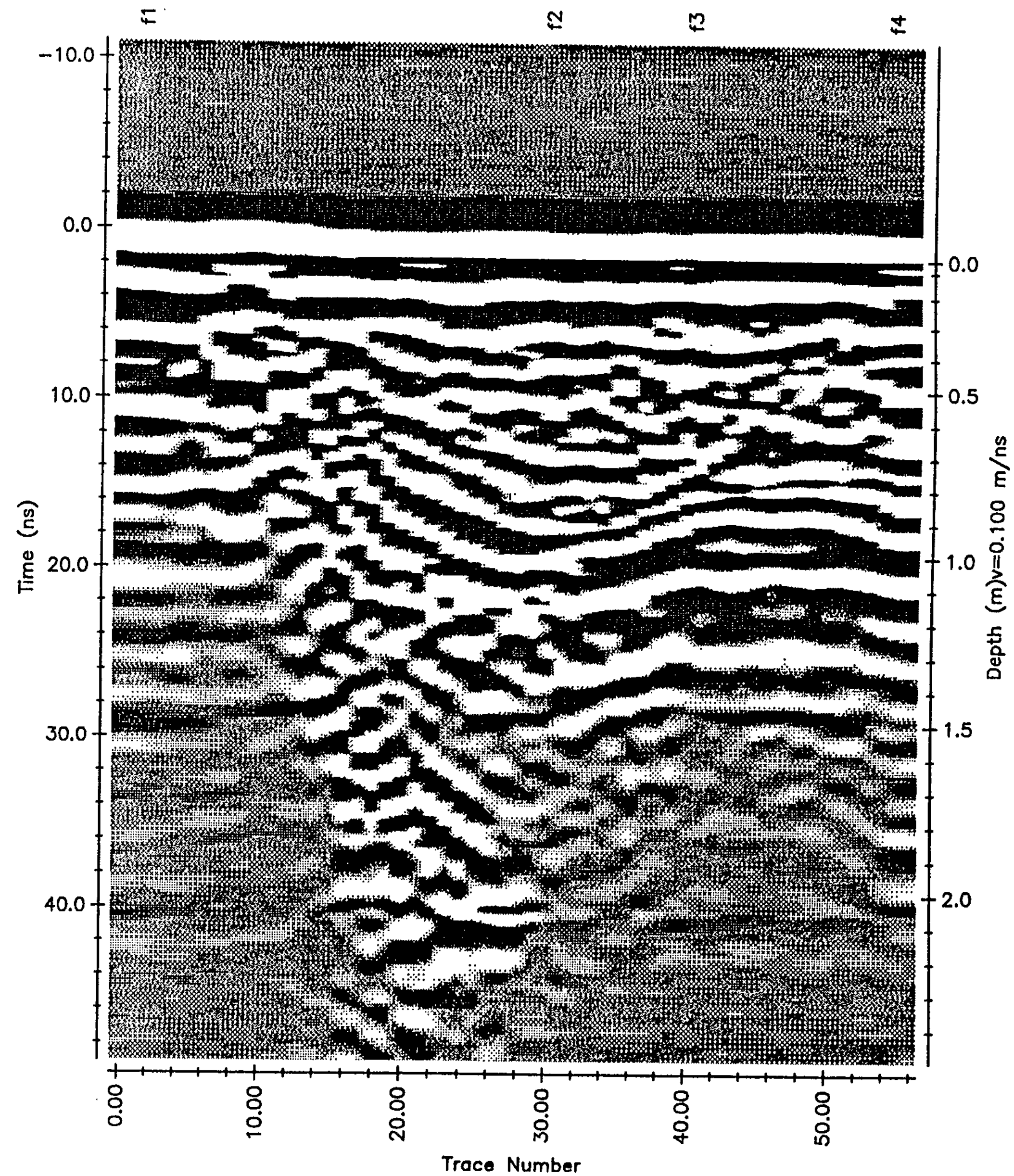
```
FILE    = s:\COASTG~1\20SEP0~1\CG450MP1
JOB#    =
TITLE   = Alabama Shipyard, Bulk Handling Area
TITLE   = Pumice Pile, 450 MHz, Pipe - West Edge of Pile
DATE    = 20/09/10
NUMBER OF TRACES      = 57
NUMBER OF PTS/TRC     = 600
TIMEZERO AT POINT     = 110
TOTAL TIME WINDOW     = 60
STARTING POSITION     = 0.000
FINAL POSITION        = 56.000
STEP SIZE USED        = 1.000
POSITION UNITS        = metres
NOMINAL FREQUENCY     = 450.00
ANTENNA SEPARATION    = 0.250
PULSER VOLTAGE        = 200
NUMBER OF STACKS      = 16
SURVEY MODE           = Reflection
COLLECTED BY PE1000 - CON: 981119 RX: 981120
                      TX: 981121 ANT: 971181/82
```

PROCESSING SELECTED

```
FILTERS:     TRACE STACKING: 2
             POINT STACKING: 2
             TRACE DIFFERENCING: N
             CORRECTION: DEWOW
SELECTION    TIME: -11 to 49
             POSITIONS: 0.000 to 56.000
GAINS:       GAIN TYPE: CONSTANT
             MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

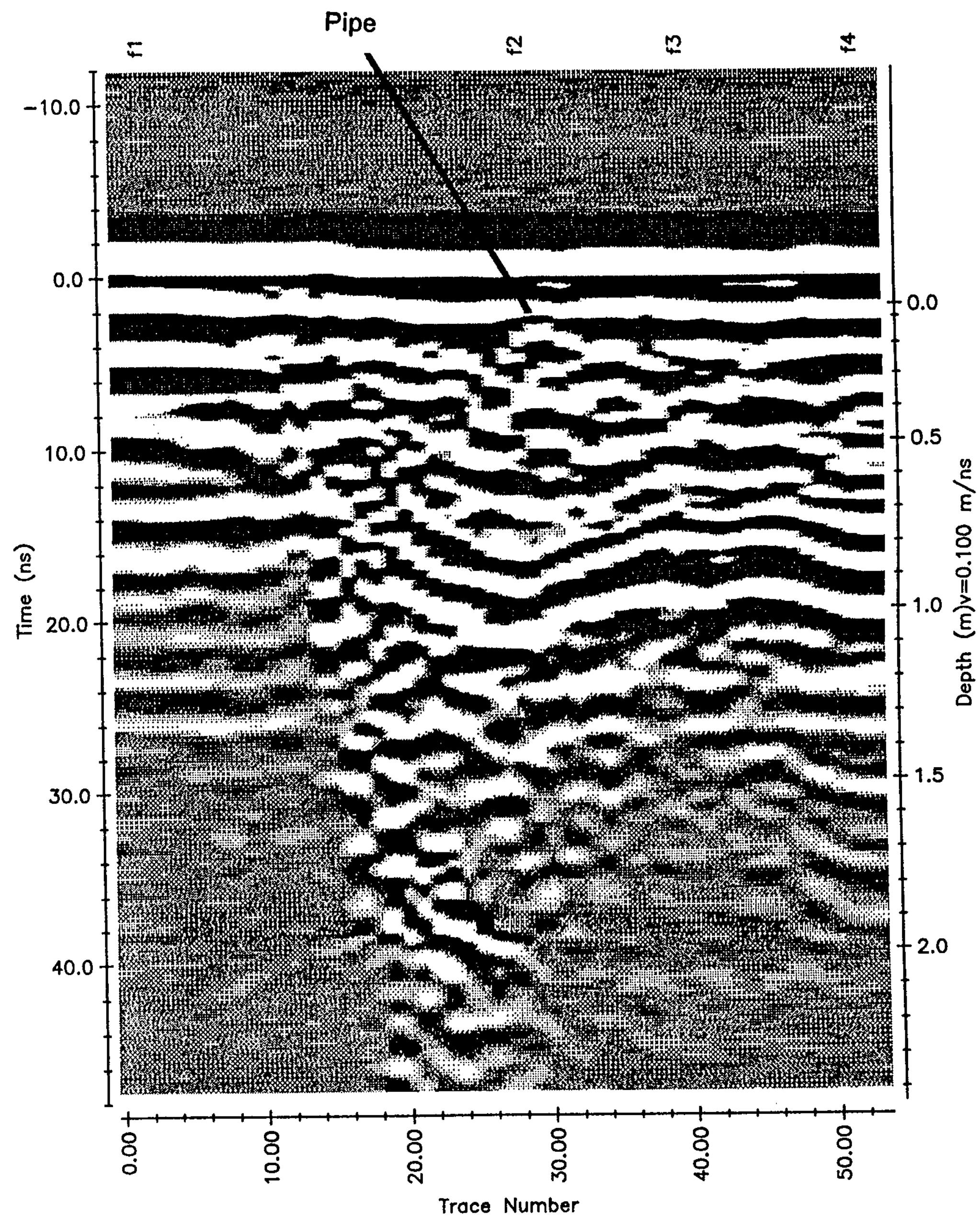
```
TRACE SPACING AND WIDTH: 0.1100 and 0.2500
TRACE BOTTOM AND TOP: 1.0000  and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\20SEP0~1\CG450MP2
     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Pumice Pile, 450 MHz, Pipe - Profile Over Pipe
     DATE   = 20/09/10
     NUMBER OF TRACES      = 54
     NUMBER OF PTS/TRC     = 600
     TIMEZERO AT POINT     = 126
     TOTAL TIME WINDOW     = 60
     STARTING POSITION     = 0.000
     FINAL POSITION        = 53.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 450.00
     ANTENNA SEPARATION    = 0.250
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 16
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971181/82

PROCESSING SELECTED
     FILTERS:      TRACE STACKING: 2
                   POINT STACKING: 2
                   TRACE DIFFERENCING: N
                   CORRECTION: DEWOW
     SELECTION     TIME: -12 to 48
                   POSITIONS: 0.000 to 53.000
     GAINS:        GAIN TYPE: CONSTANT
                   MULTIPLIER: 100.000

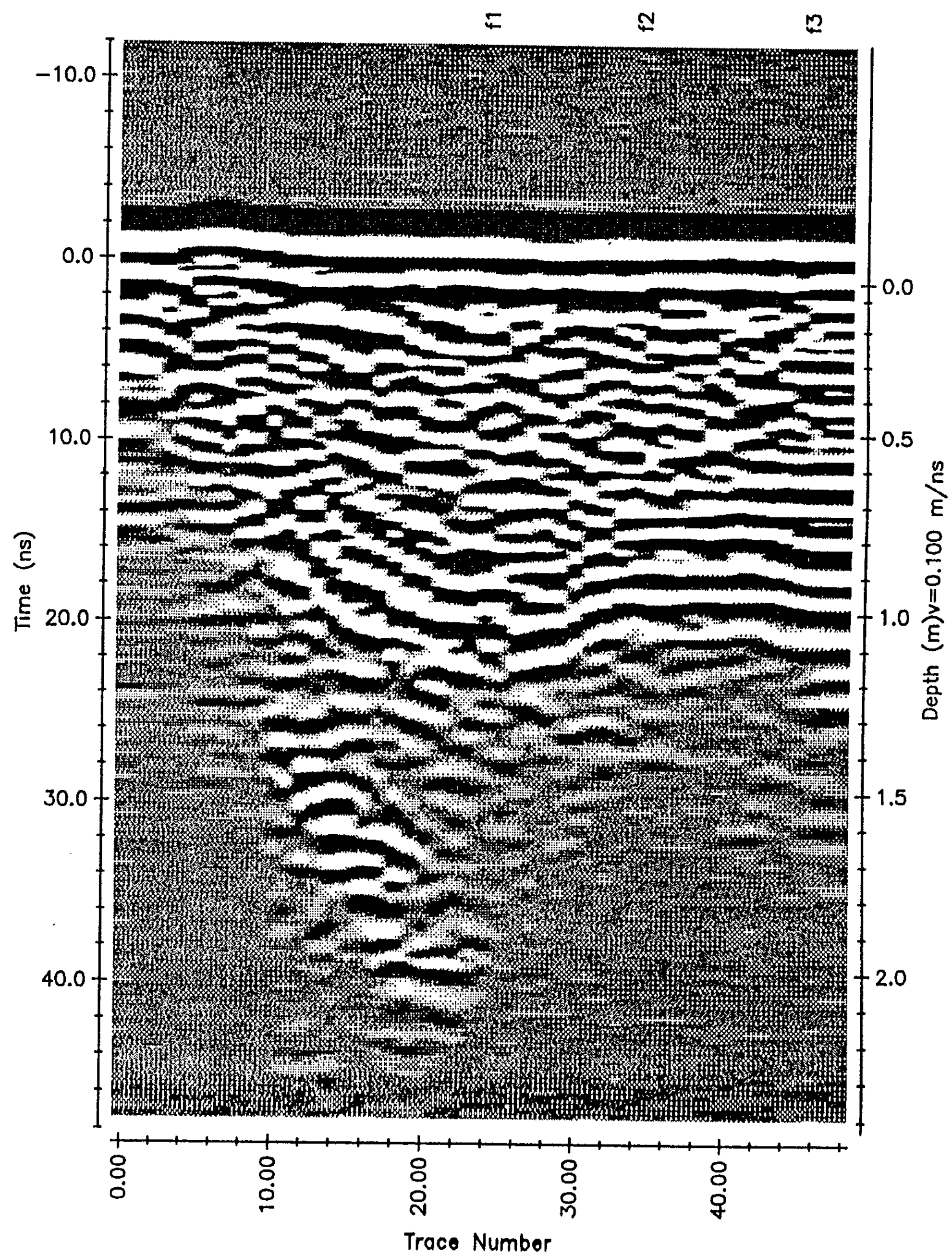
PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.1100 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 .and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\20SEP0~1\CG900MP1
     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Pumice Pile, 900 MHz, Pipe - West Edge of Pile
     DATE   = 20/09/10
     NUMBER OF TRACES      = 49
     NUMBER OF PTS/TRC     = 600
     TIMEZERO AT POINT     = 126
     TOTAL TIME WINDOW     = 60
     STARTING POSITION     = 0.000
     FINAL POSITION        = 48.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 900.00
     ANTENNA SEPARATION    = 0.170
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 16
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971258/59

PROCESSING SELECTED
     FILTERS:    TRACE STACKING: 2
                 POINT STACKING: 2
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
     SELECTION   TIME: -12 to 48
                 POSITIONS: 0.000 to 48.000
     GAINS:      GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000

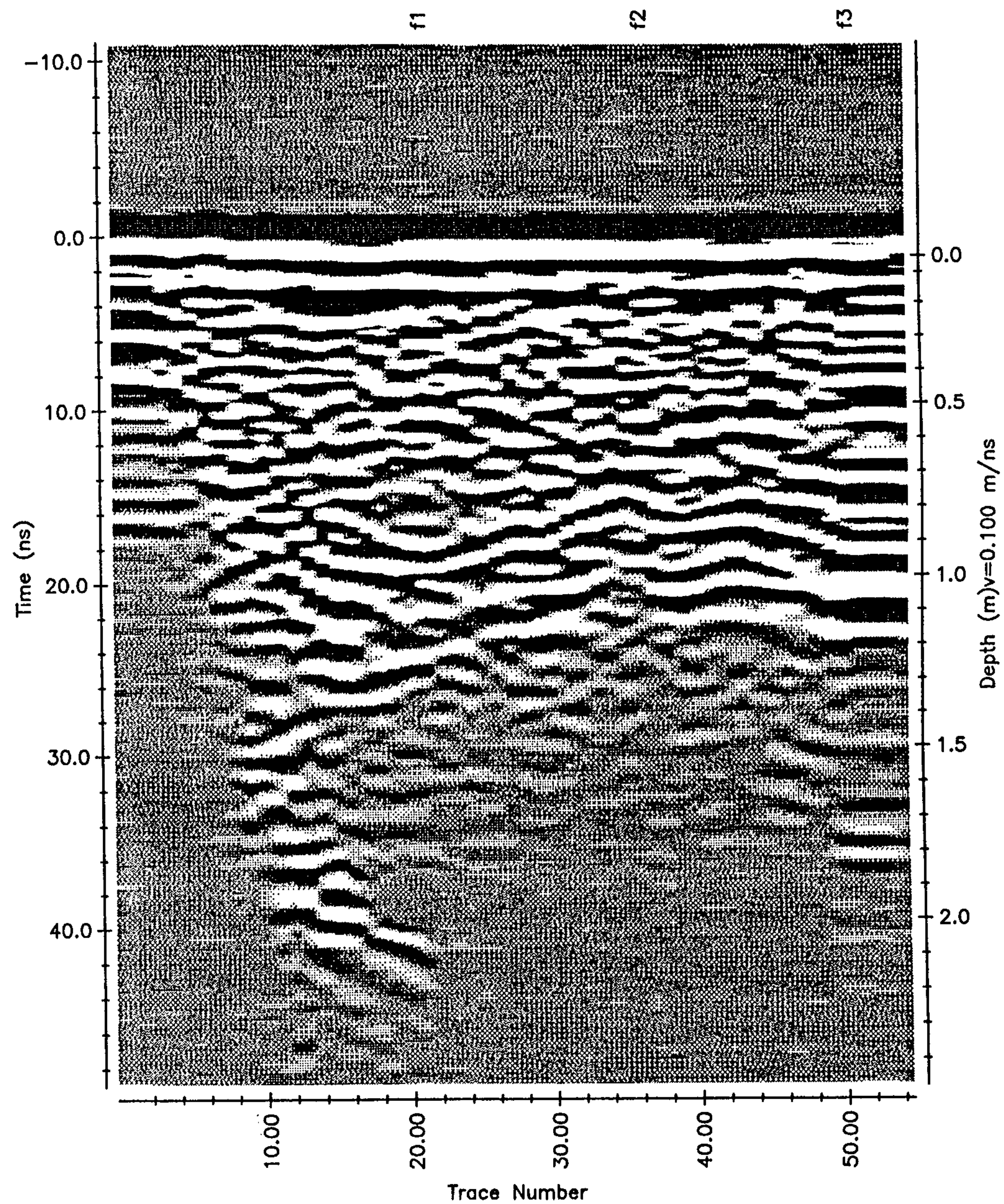
PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.1100 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\20SEP0~1\CG900MP2
     JOB#  =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Pumice Pile, 900 MHz, Pipe - Profile Over Pipe
     DATE   = 20/09/10
     NUMBER OF TRACES      = 55
     NUMBER OF PTS/TRC     = 600
     TIMEZERO AT POINT     = 111
     TOTAL TIME WINDOW     = 60
     STARTING POSITION     = 0.000
     FINAL POSITION        = 54.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 900.00
     ANTENNA SEPARATION    = 0.170
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 16
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971258/59

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 2
                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -11 to 49
                  POSITIONS: 0.000 to 54.000
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.1100 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

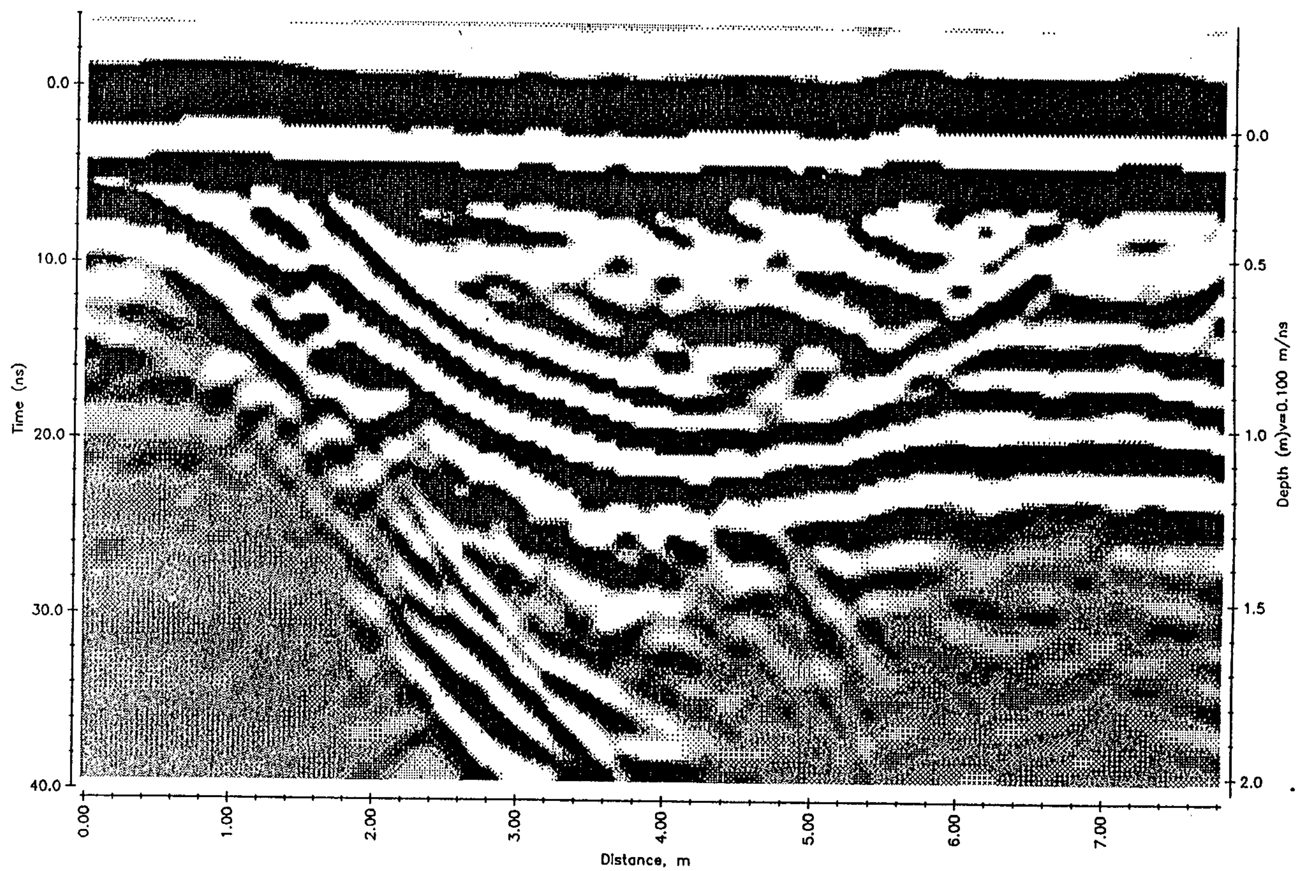
```
FILE   = s:\COASTG~1\20SEP0~1\CG250MPO
JOB#   =
TITLE  = Alabama Shipyard, Bulk Handling Area
TITLE  = Pumice Pile, 250 MHz, Pipe -- West Edge of Pile
DATE   = 09/20/20
NUMBER OF TRACES     = 157
NUMBER OF PTS/TRC    = 111
TIMEZERO AT POINT    = 11
TOTAL TIME WINDOW    = 44
STARTING POSITION    = 0.000
FINAL POSITION       = 7.800
STEP SIZE USED       = 0.050
POSITION UNITS       = m
NOMINAL FREQUENCY    = 250.00
ANTENNA SEPARATION   = 0.305
PULSER VOLTAGE       = 100
NUMBER OF STACKS     = 16
SURVEY MODE          = Reflection
```

PROCESSING SELECTED

```
FILTERS:    TRACE STACKING: 2
            POINT STACKING: 2
            TRACE DIFFERENCING: N
            CORRECTION: DEWOW
SELECTION   TIME: -4 to 40
            POSITIONS: 0.000 to 7.800
GAINS:      GAIN TYPE: CONSTANT
            MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

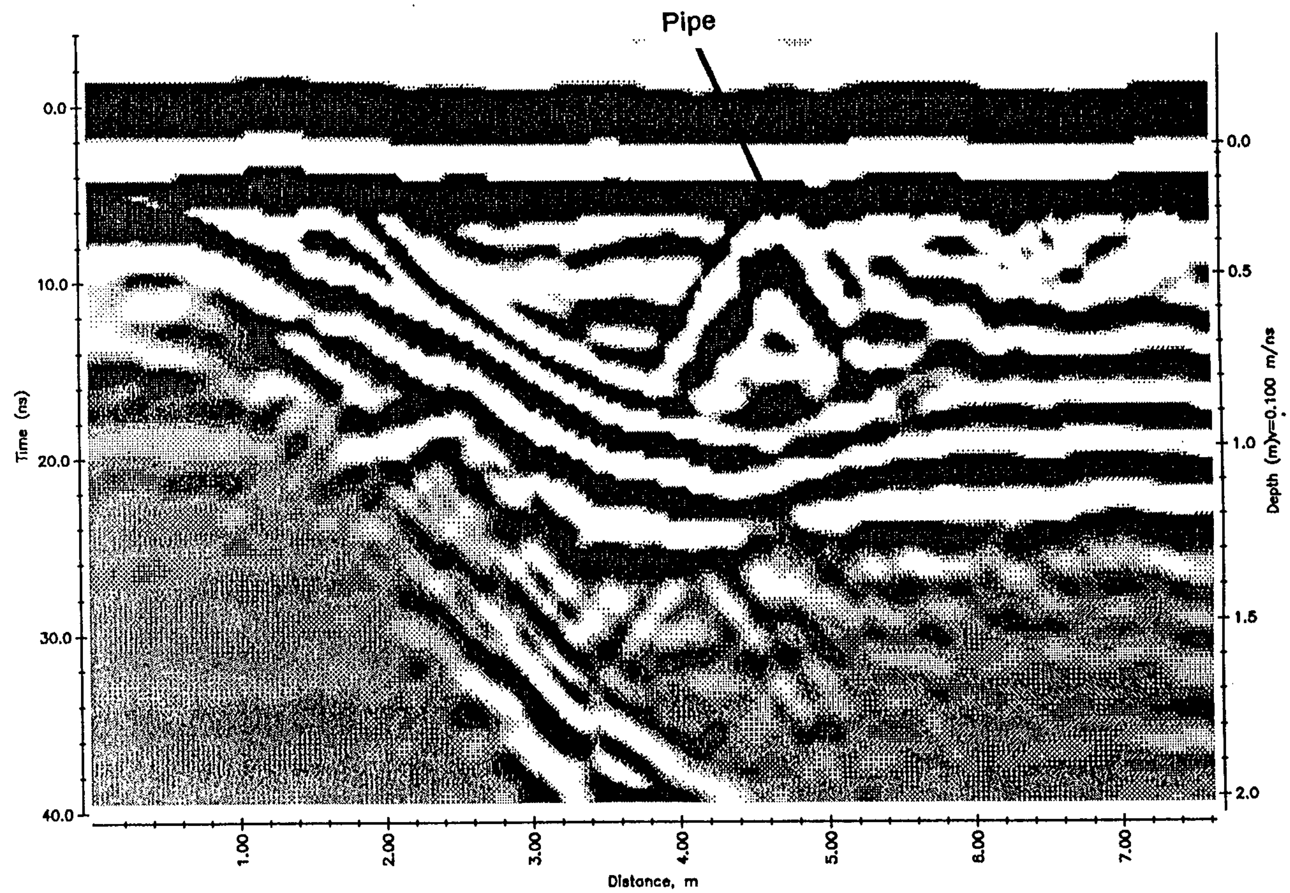
```
TRACE SPACING AND WIDTH: 0.0750 and 0.2500
TRACE BOTTOM AND TOP: 1.0000  and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS
FILE = s:\COASTG~1\20SEP0~1\CG250MP1
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Pumice Pile, 250 MHz, Pipe – Profile Over Pipe
DATE = 09/20/20
NUMBER OF TRACES = 153
NUMBER OF PTS/TRC = 111
TIMEZERO AT POINT = 11
TOTAL TIME WINDOW = 44
STARTING POSITION = 0.000
FINAL POSITION = 7.600
STEP SIZE USED = 0.050
POSITION UNITS = m
NOMINAL FREQUENCY = 250.00
ANTENNA SEPARATION = 0.305
PULSER VOLTAGE = 100
NUMBER OF STACKS = 16
SURVEY MODE = Reflection

PROCESSING SELECTED
FILTERS: TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: –4 to 40
POSITIONS: 0.000 to 7.600
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0750 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: –0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



Appendix D
Coarse Coal
GPR Records - Initial Investigation

pulseEKKO HEADER PARAMETERS

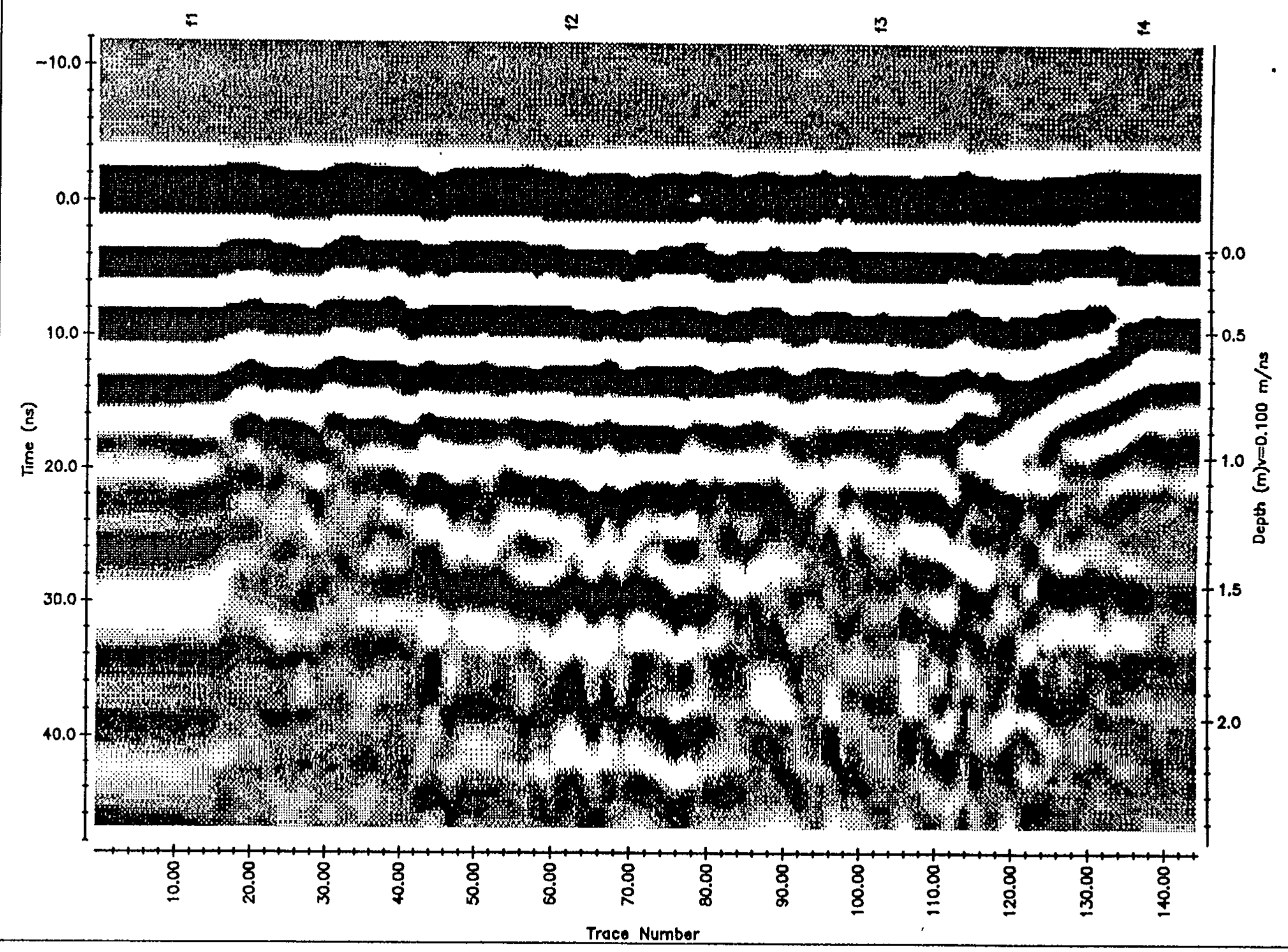
```
FILE   = s:\COASTG~1\20SEP0~1\CG225CP1
JOB#   =
TITLE  = Alabama Shipyard, Bulk Handling Area
TITLE  = Coal (coarse) Pile, 225 MHz, Pipe - North Edge of Pipe
DATE   = 20/09/10
NUMBER OF TRACES    = 145
NUMBER OF PTS/TRC   = 200
TIMEZERO AT POINT   = 43
TOTAL TIME WINDOW   = 60
STARTING POSITION   = 0.000
FINAL POSITION      = 144.000
STEP SIZE USED      = 1.000
POSITION UNITS      = metres
NOMINAL FREQUENCY   = 225.00
ANTENNA SEPARATION  = 0.500
PULSER VOLTAGE      = 200
NUMBER OF STACKS    = 16
SURVEY MODE         = Reflection
COLLECTED BY PE1000 - CON: 981119 RX: 981120
                      TX: 981121 ANT: 971195/96
```

PROCESSING SELECTED

```
FILTERS:    TRACE STACKING: 2
            POINT STACKING: 2
            TRACE DIFFERENCING: N
            CORRECTION: DEWOW
SELECTION   TIME: -12 to 48
            POSITIONS: 0.000 to 144.000
GAINS:      GAIN TYPE: CONSTANT
            MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

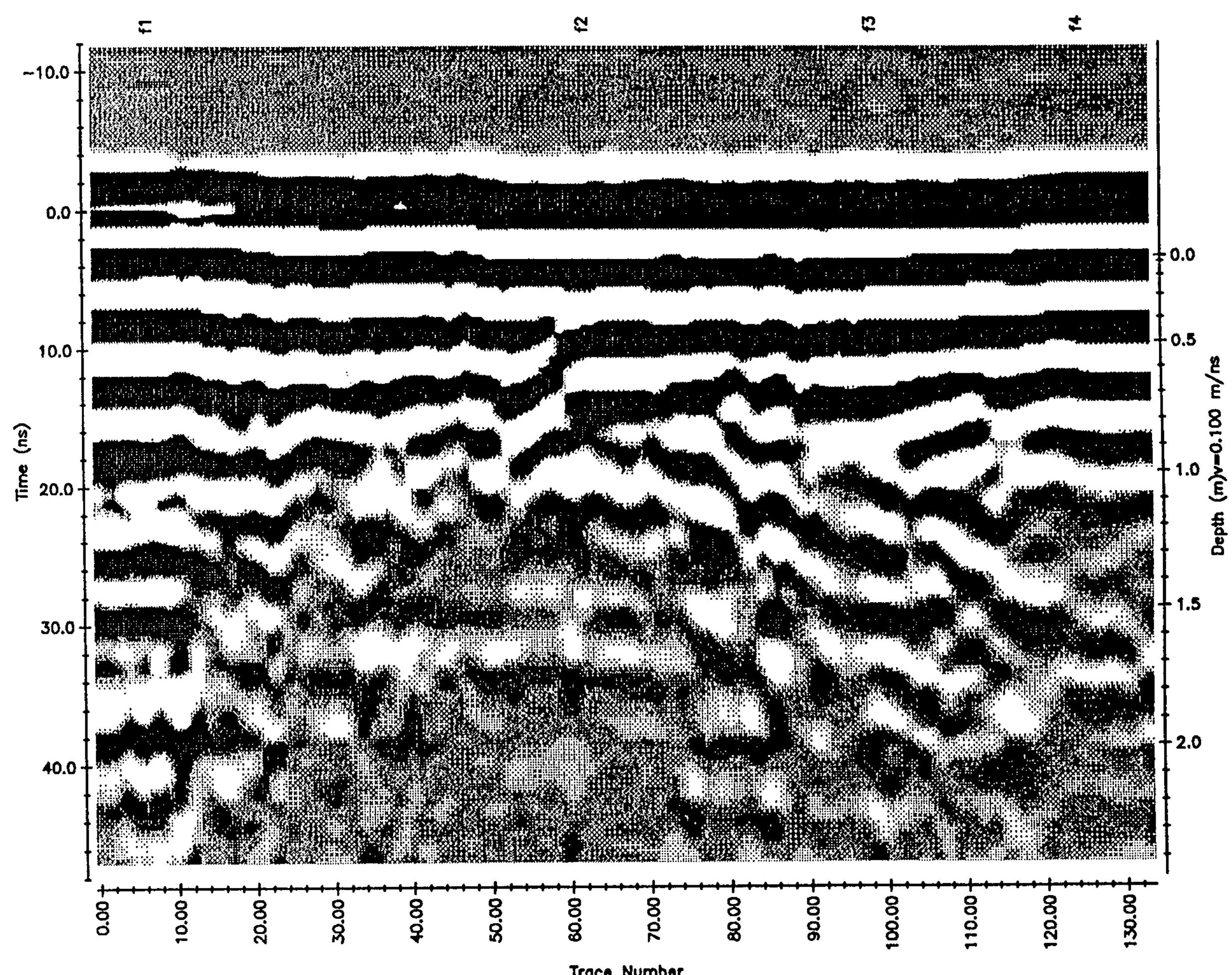
```
TRACE SPACING AND WIDTH: 0.0750 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
    FILE   = s:\COASTG~1\20SEP0~1\CG225CP2
    JOB#   =
    TITLE  = Alabama Shipyard, Bulk Handling Area
    TITLE  = Coal (coarse) Pile, 225 MHz, Pipe - Profile Over Pipe
    DATE   = 20/09/10
    NUMBER OF TRACES       = 134
    NUMBER OF PTS/TRC      = 200
    TIMEZERO AT POINT      = 43
    TOTAL TIME WINDOW      = 60
    STARTING POSITION      = 0.000
    FINAL POSITION         = 133.000
    STEP SIZE USED         = 1.000
    POSITION UNITS         = metres
    NOMINAL FREQUENCY      = 225.00
    ANTENNA SEPARATION     = 0.500
    PULSER VOLTAGE         = 200
    NUMBER OF STACKS       = 16
    SURVEY MODE            = Reflection
    COLLECTED BY PE1000 - CON: 981119 RX: 981120
                          TX: 981121 ANT: 971195/96

PROCESSING SELECTED
    FILTERS:      TRACE STACKING: 2
                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
    SELECTION     TIME: -12 to 48
                  POSITIONS: 0.000 to 133.000
    GAINS:        GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.0750 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

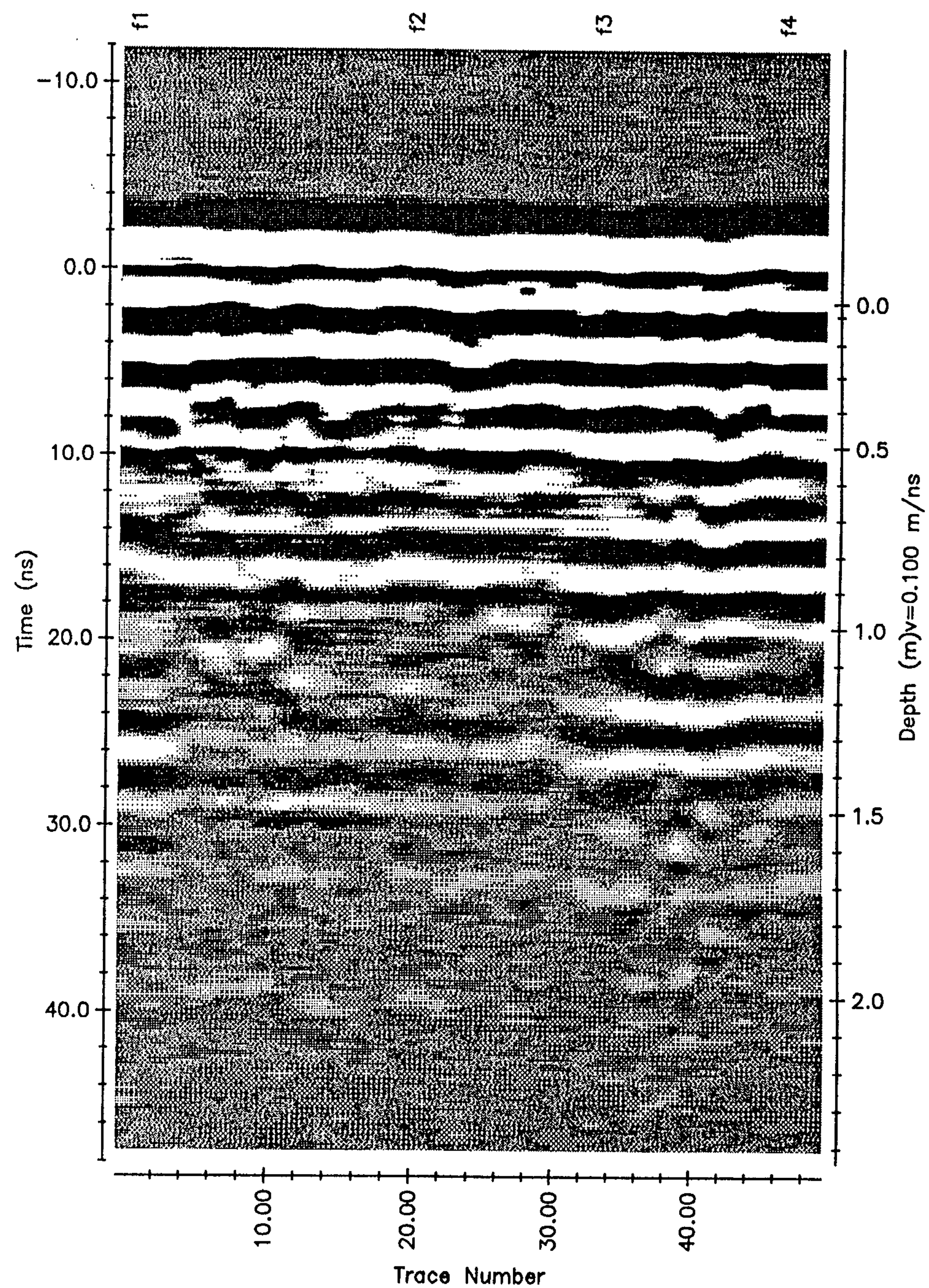
```
FILE   = s:\COASTG~1\20SEP0~1\CG450CP1
JOB#   =
TITLE  = Alabama Shipyard, Bulk Handling Area ,
TITLE  = Coal (coarse) Pile, 450 MHz, Pipe - North Edge of Pile
DATE   = 20/09/10
NUMBER OF TRACES      = 50
NUMBER OF PTS/TRC     = 600
TIMEZERO AT POINT     = 126
TOTAL TIME WINDOW     = 60
STARTING POSITION     = 0.000
FINAL POSITION        = 49.000
STEP SIZE USED        = 1.000
POSITION UNITS        = metres
NOMINAL FREQUENCY     = 450.00
ANTENNA SEPARATION    = 0.250
PULSER VOLTAGE        = 200
NUMBER OF STACKS      = 16
SURVEY MODE           = Reflection
COLLECTED BY PE1000 - CON: 981119 RX: 981120
                      TX: 981121 ANT: 971181/82
```

PROCESSING SELECTED

```
FILTERS:    TRACE STACKING: 2
            POINT STACKING: 2
            TRACE DIFFERENCING: N
            CORRECTION: DEWOW
SELECTION   TIME: -12 to 48
            POSITIONS: 0.000 to 49.000
GAINS:      GAIN TYPE: CONSTANT
            MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

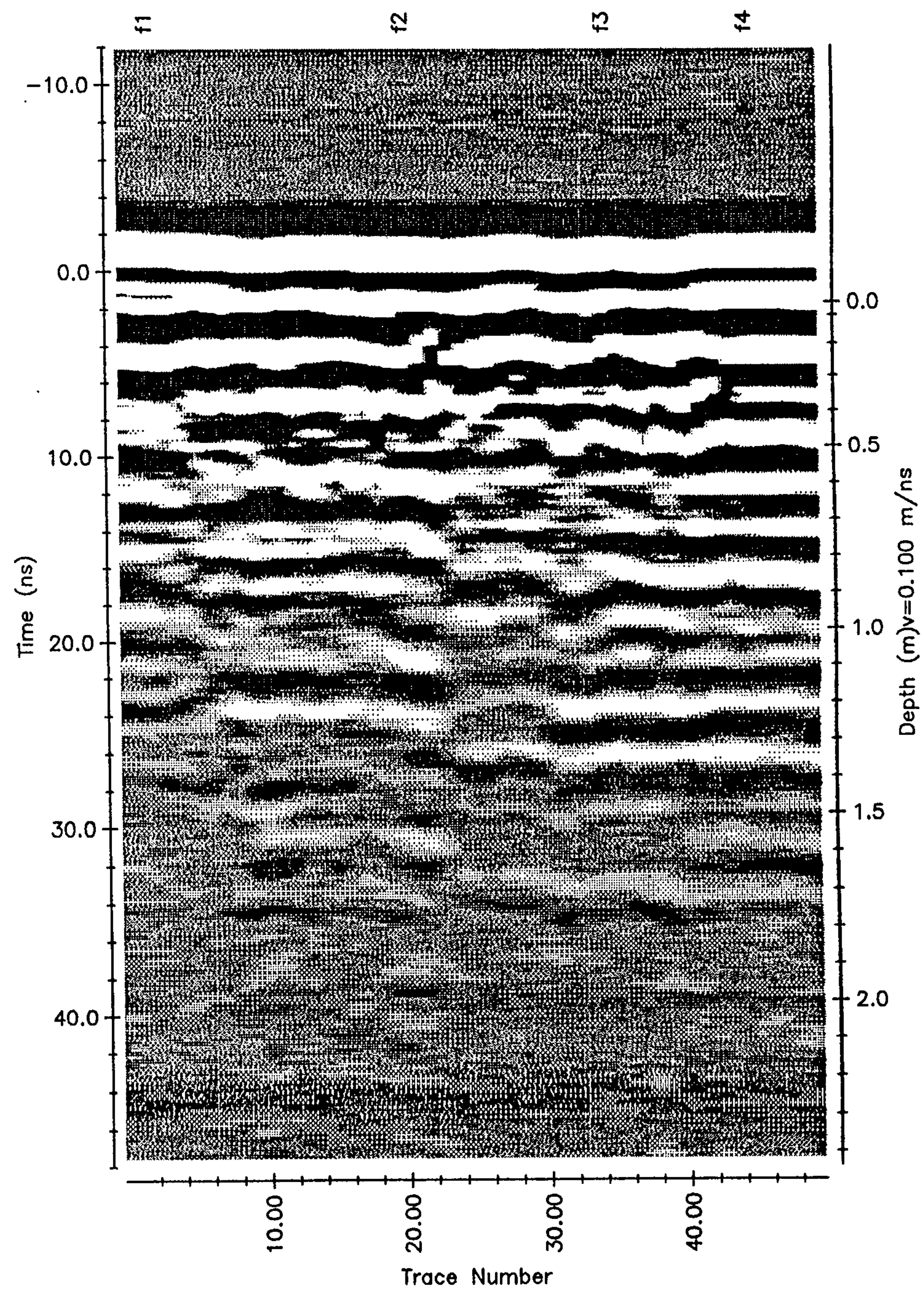
```
TRACE SPACING AND WIDTH: 0.1000 and 0.2500
TRACE BOTTOM AND TOP: 1.0000  and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
    FILE  = s:\COASTG~1\20SEP0~1\CG450CP2
    JOB#  =
    TITLE = Alabama Shipyard, Bulk Handling Area  ,
    TITLE = Coal (coarse) Pile, 450 MHz, Pipe - Profile Over Pipe
    DATE  = 20/09/10
    NUMBER OF TRACES      = 50
    NUMBER OF PTS/TRC     = 600
    TIMEZERO AT POINT     = 124
    TOTAL TIME WINDOW     = 60
    STARTING POSITION     = 0.000
    FINAL POSITION        = 49.000
    STEP SIZE USED        = 1.000
    POSITION UNITS        = metres
    NOMINAL FREQUENCY     = 450.00
    ANTENNA SEPARATION    = 0.250
    PULSER VOLTAGE        = 200
    NUMBER OF STACKS      = 16
    SURVEY MODE           = Reflection
    COLLECTED BY PE1000 - CON: 981119 RX: 981120
                          TX: 981121 ANT: 971181/82

PROCESSING SELECTED
    FILTERS:    TRACE STACKING: 2
                POINT STACKING: 2
                TRACE DIFFERENCING: N
                CORRECTION: DEWOW
    SELECTION   TIME: -12 to 48
                POSITIONS: 0.000 to 49.000
    GAINS:      GAIN TYPE: CONSTANT
                MULTIPLIER: 100.000

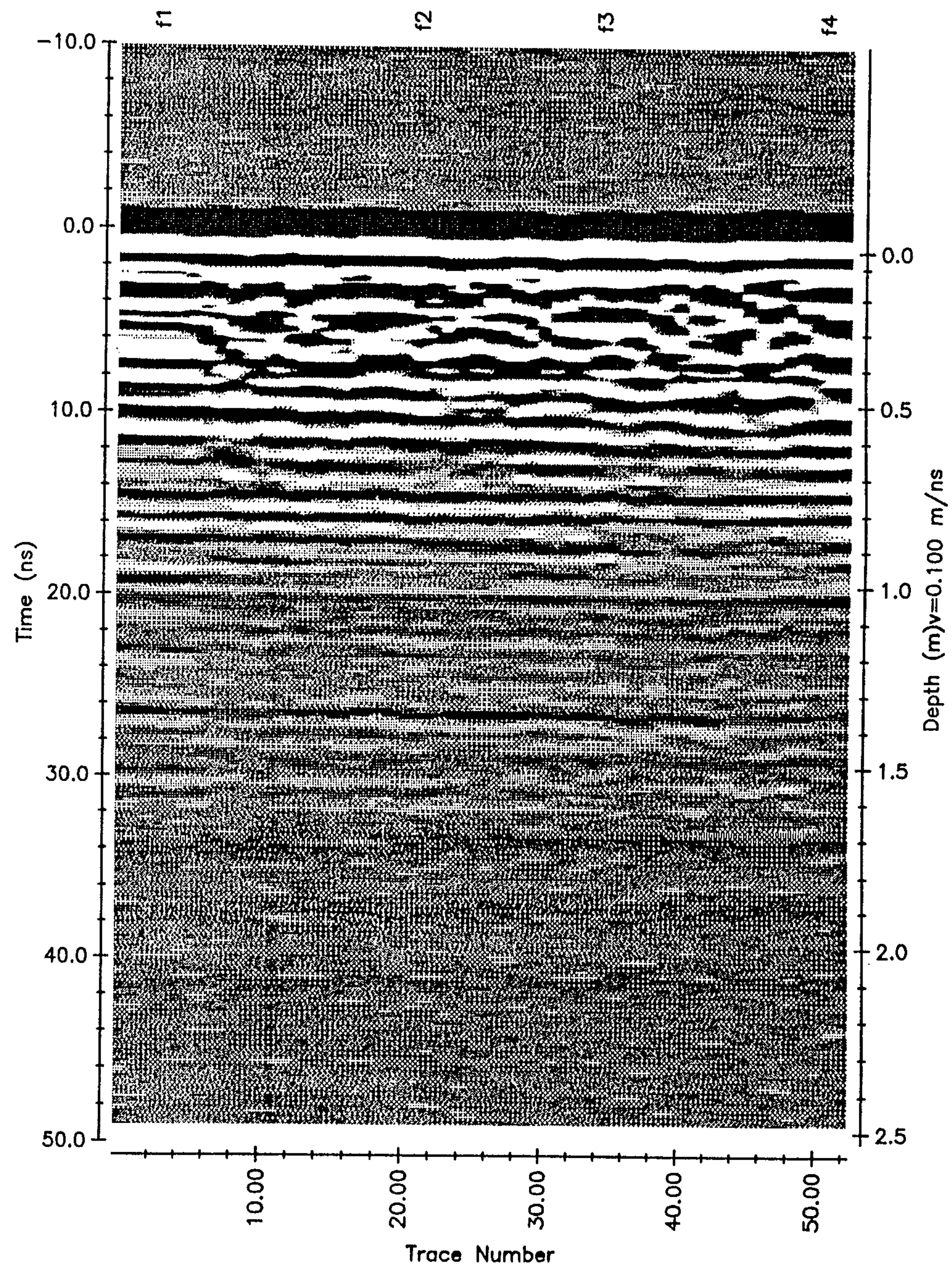
PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.1000 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\20SEP0~1\CG900CP1
     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Coal (coarse) Pile, 900 MHz, Pipe - North Edge of Pile
     DATE   = 20/09/10
     NUMBER OF TRACES     = 53
     NUMBER OF PTS/TRC    = 600
     TIMEZERO AT POINT    = 109
     TOTAL TIME WINDOW    = 60
     STARTING POSITION    = 0.000
     FINAL POSITION       = 52.000
     STEP SIZE USED       = 1.000
     POSITION UNITS       = metres
     NOMINAL FREQUENCY    = 900.00
     ANTENNA SEPARATION   = 0.170
     PULSER VOLTAGE       = 200
     NUMBER OF STACKS     = 16
     SURVEY MODE          = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971258/59

PROCESSING SELECTED
     FILTERS:    TRACE STACKING: 2
                 POINT STACKING: 2
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
     SELECTION   TIME: -10 to 50
                 POSITIONS: 0.000 to 52.000
     GAINS:      GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000

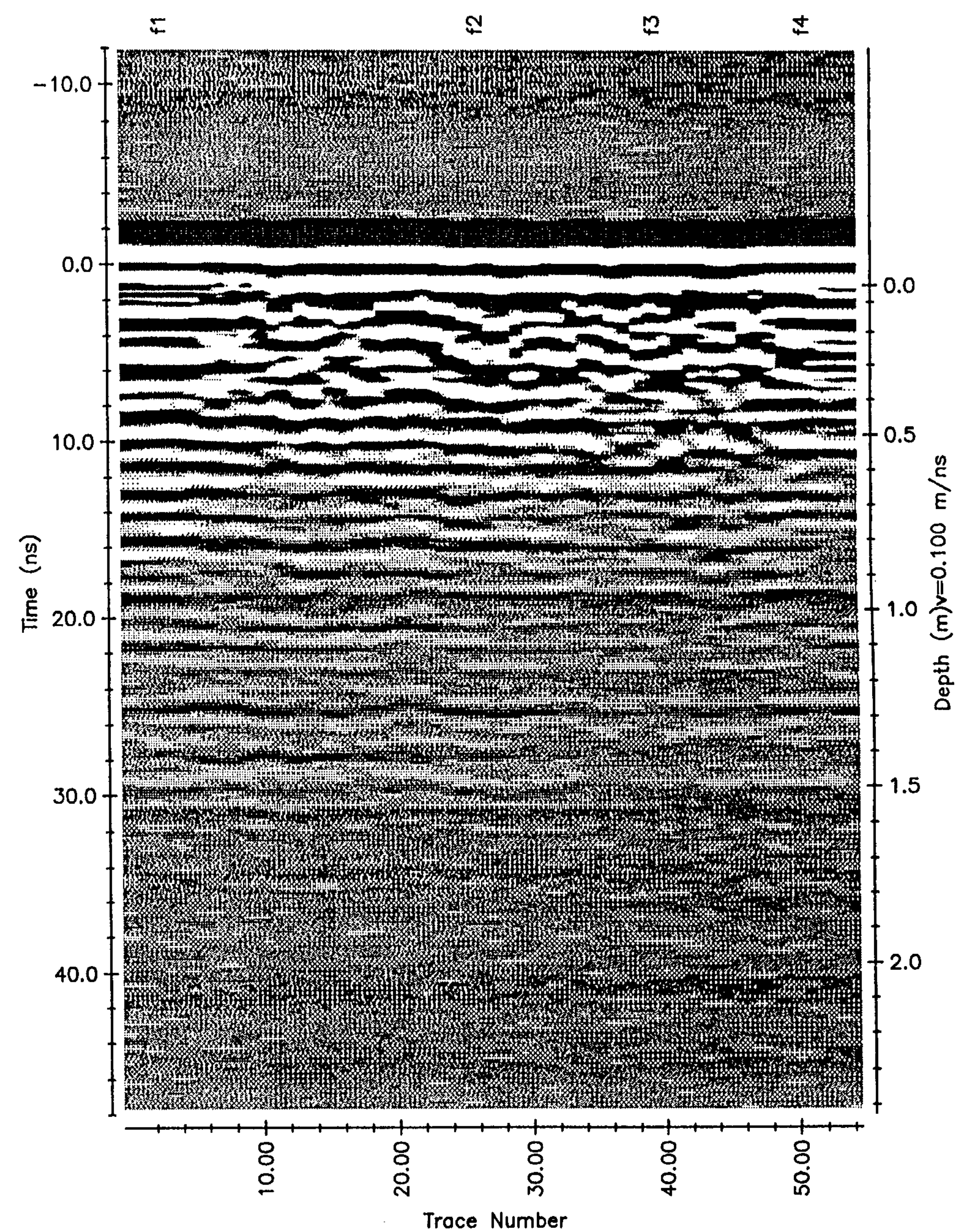

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.1000 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
    FILE  = s:\COASTG~1\20SEP0~1\CG900CP2
    JOB#  =
    TITLE = Alabama Shipyard, Bulk Handling Area
    TITLE = Coal (coarse) Pile, 900 MHz, Pipe - Profile Over Pipe
    DATE  = 20/09/10
    NUMBER OF TRACES    = 55
    NUMBER OF PTS/TRC   = 600
    TIMEZERO AT POINT   = 123
    TOTAL TIME WINDOW   = 60
    STARTING POSITION   = 0.000
    FINAL POSITION      = 54.000
    STEP SIZE USED      = 1.000
    POSITION UNITS      = metres
    NOMINAL FREQUENCY   = 900.00
    ANTENNA SEPARATION  = 0.170
    PULSER VOLTAGE      = 200
    NUMBER OF STACKS    = 16
    SURVEY MODE         = Reflection
    COLLECTED BY PE1000 - CON: 981119 RX: 981120
                          TX: 981121 ANT: 971258/59

PROCESSING SELECTED
    FILTERS:    TRACE STACKING: 2
                POINT STACKING: 2
                TRACE DIFFERENCING: N
                CORRECTION: DEWOW
    SELECTION   TIME: -12 to 48
                POSITIONS: 0.000 to 54.000
    GAINS:      GAIN TYPE: CONSTANT
                MULTIPLIER: 100.000

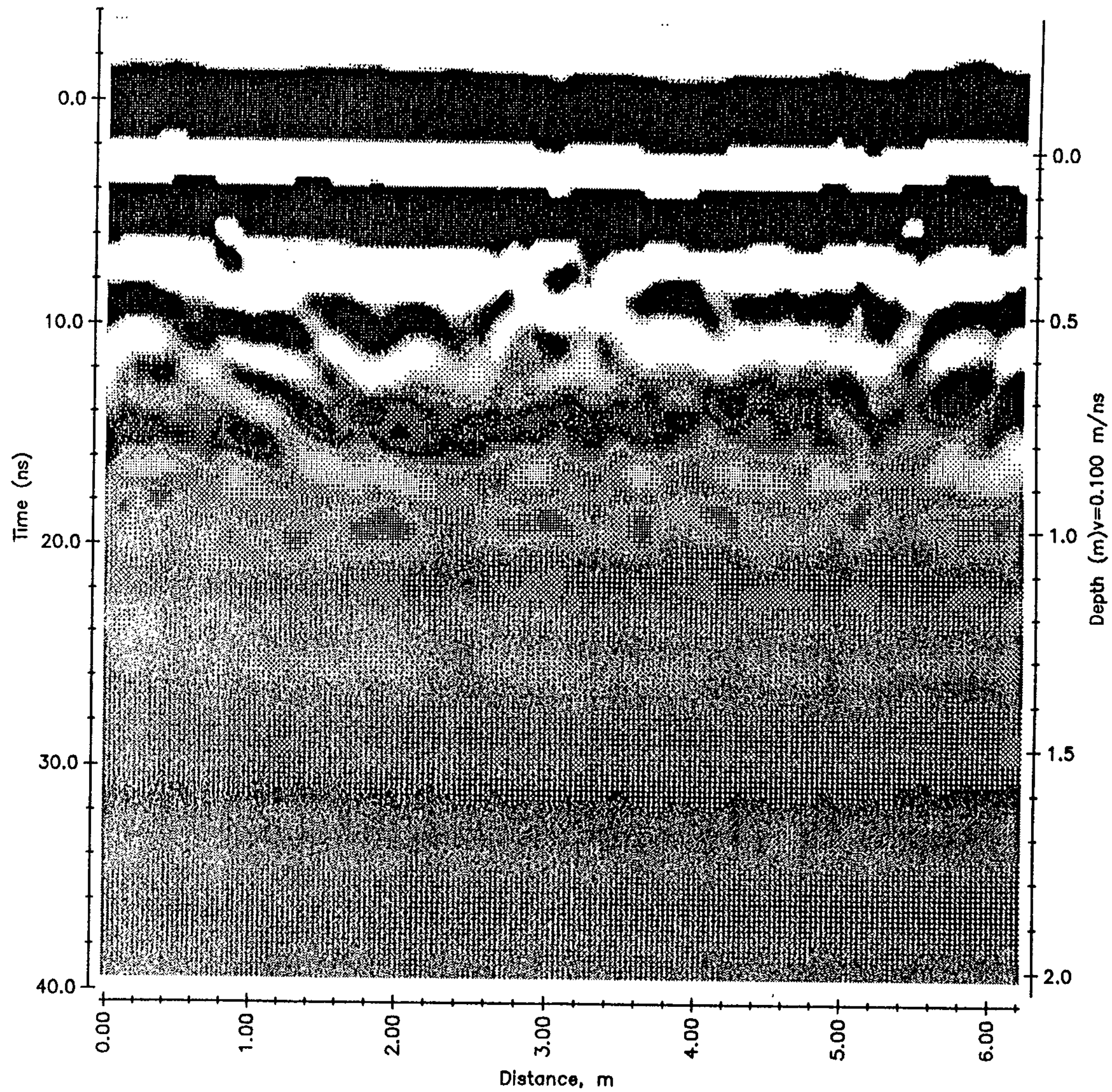

PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.1000 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
      FILE   = s:\COASTG~1\20SEP0~1\CG250CP0
      JOB#   =
      TITLE  = Alabama Shipyard, Bulk Handling Area
      TITLE  = Coal (coarse) Pile, 250 MHz, Pipe - North Edge of Pile
      DATE   = 09/20/20
      NUMBER OF TRACES    = 125
      NUMBER OF PTS/TRC   = 111
      TIMEZERO AT POINT   = 11
      TOTAL TIME WINDOW   = 44
      STARTING POSITION   = 0.000
      FINAL POSITION      = 6.200
      STEP SIZE USED      = 0.050
      POSITION UNITS      = m
      NOMINAL FREQUENCY   = 250.00
      ANTENNA SEPARATION  = 0.305
      PULSER VOLTAGE      = 100
      NUMBER OF STACKS    = 16
      SURVEY MODE         = Reflection

PROCESSING SELECTED
      FILTERS:      TRACE STACKING: 2
                    POINT STACKING: 2
                    TRACE DIFFERENCING: N
                    CORRECTION: DEWOW
      SELECTION     TIME: -4 to 40
                    POSITIONS: 0.000 to 6.200
      GAINS:        GAIN TYPE: CONSTANT
                    MULTIPLIER: 100.000

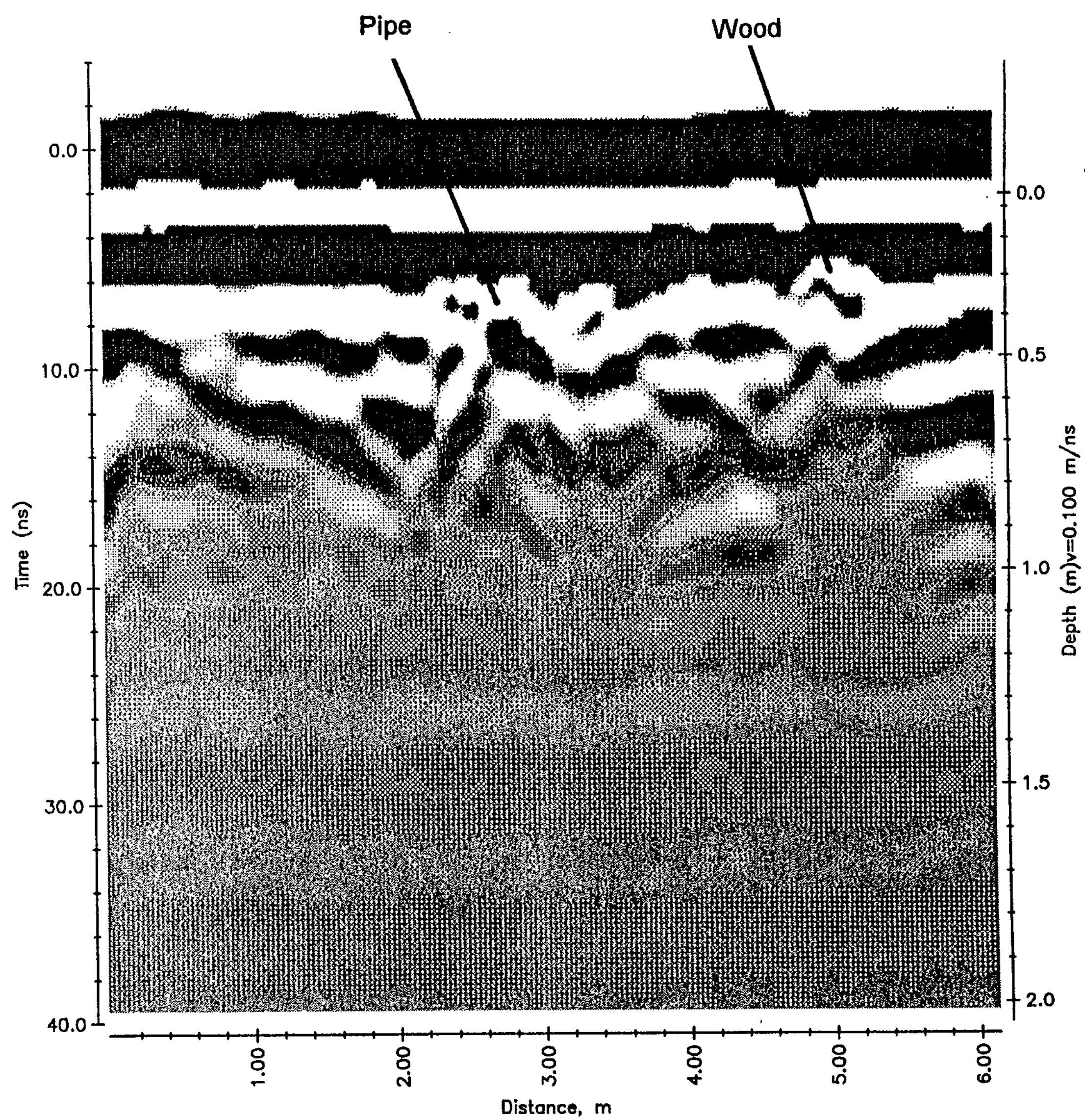
PLOT LAYOUT PARAMETERS
      TRACE SPACING AND WIDTH: 0.0600 and 0.2500
      TRACE BOTTOM AND TOP: 1.0000  and 9.0000
      MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
      PAGE WIDTH: 10.0000
      BORDER SIZE: 0.000
      PRINTER NAME: LAS300
      SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
    FILE  = s:\COASTG~1\20SEP0~1\CG250CP1
    JOB#  =
    TITLE = Alabama Shipyard, Bulk Handling Area
    TITLE = Coal (coarse) Pile, 250 MHz, Pipe - Profile Over Pipe
    DATE  = 09/20/20
    NUMBER OF TRACES     = 123
    NUMBER OF PTS/TRC    = 111
    TIMEZERO AT POINT    = 11
    TOTAL TIME WINDOW    = 44
    STARTING POSITION    = 0.000
    FINAL POSITION       = 6.100
    STEP SIZE USED       = 0.050
    POSITION UNITS       = m
    NOMINAL FREQUENCY    = 250.00
    ANTENNA SEPARATION   = 0.305
    PULSER VOLTAGE       = 100
    NUMBER OF STACKS     = 16
    SURVEY MODE          = Reflection

PROCESSING SELECTED
    FILTERS:    TRACE STACKING: 2
                POINT STACKING: 2
                TRACE DIFFERENCING: N
                CORRECTION: DEWOW
    SELECTION   TIME: -4 to 40
                POSITIONS: 0.000 to 6.100
    GAINS:      GAIN TYPE: CONSTANT
                MULTIPLIER: 100.000


PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.0600 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

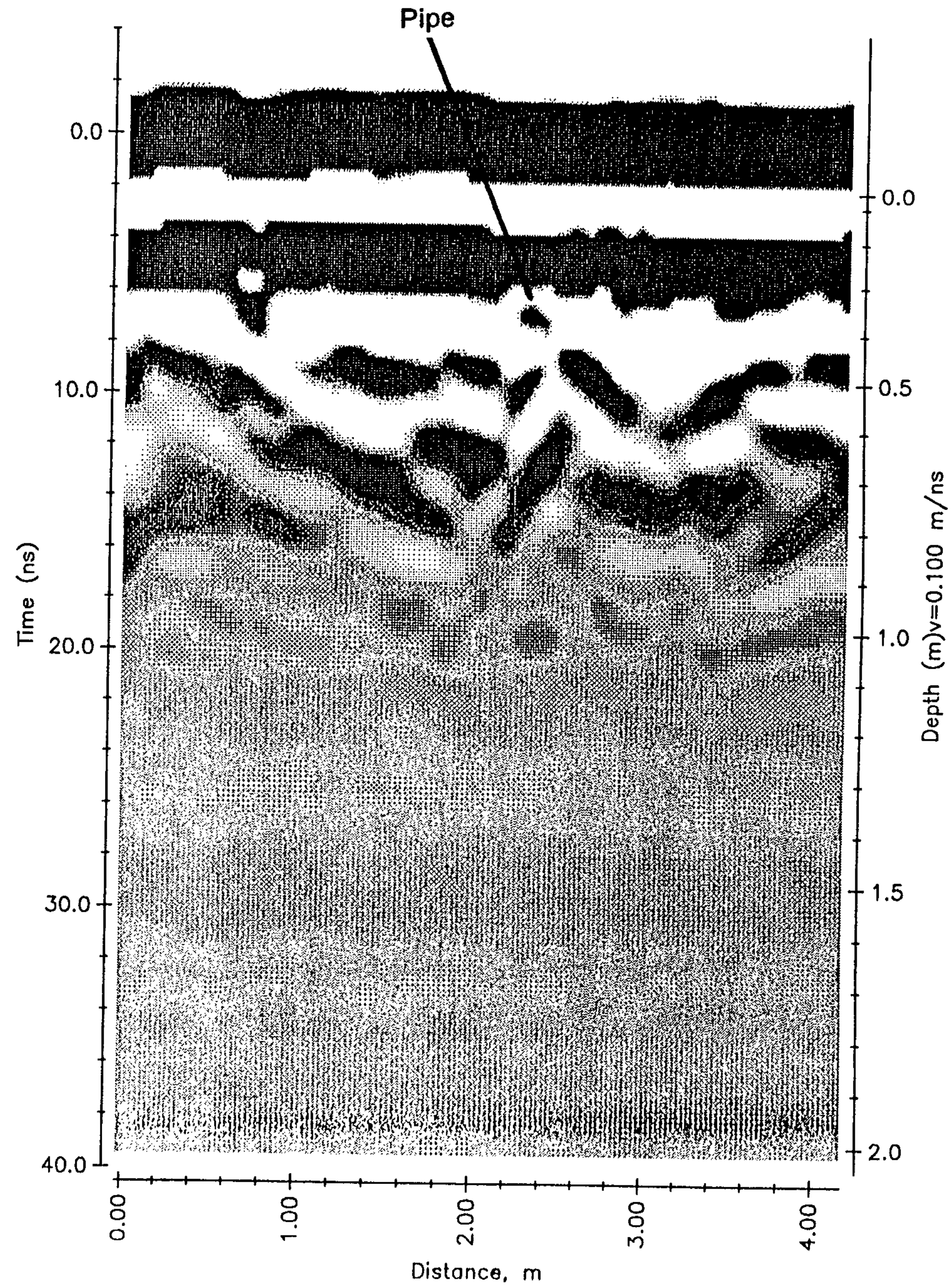
```
FILE  = s:\COASTG~1\20SEP0~1\CG250CP2
JOB#  =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Coal (coarse) Pile, 250 MHz, Pipe - Profile Over Pipe
DATE  = 09/20/20
NUMBER OF TRACES       = 84
NUMBER OF PTS/TRC      = 111
TIMEZERO AT POINT      = 11
TOTAL TIME WINDOW      = 44
STARTING POSITION      = 0.000
FINAL POSITION         = 4.150
STEP SIZE USED         = 0.050
POSITION UNITS         = m
NOMINAL FREQUENCY      = 250.00
ANTENNA SEPARATION     = 0.305
PULSER VOLTAGE         = 100
NUMBER OF STACKS       = 16
SURVEY MODE            = Reflection
```

PROCESSING SELECTED

```
FILTERS:    TRACE STACKING: 2
            POINT STACKING: 2
            TRACE DIFFERENCING: N
            CORRECTION: DEWOW
SELECTION   TIME: -4 to 40
            POSITIONS: 0.000 to 4.150
GAINS:      GAIN TYPE: CONSTANT
            MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

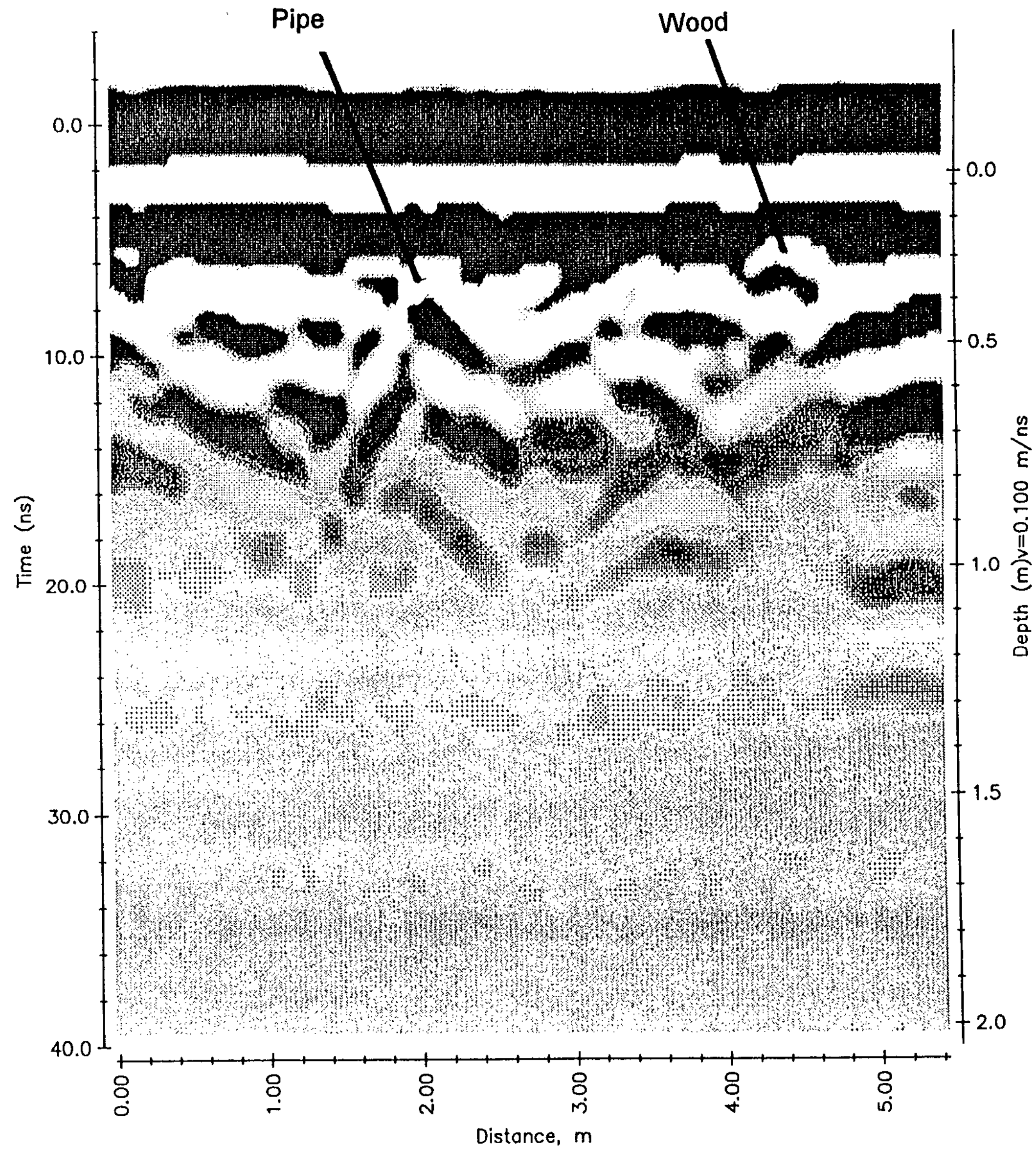
```
TRACE SPACING AND WIDTH: 0.0600 and 0.2500
TRACE BOTTOM AND TOP: 1.0000  and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE     = s:\COASTG~1\20SEP0~1\CG250CP3
     JOB#     =
     TITLE    = Alabama Shipyard, Bulk Handling Area
     TITLE    = Coal (coarse) Pile, 250 MHz, Pipe - Profile Over Pipe
     DATE     = 09/20/20
     NUMBER OF TRACES       = 109
     NUMBER OF PTS/TRC      = 111
     TIMEZERO AT POINT      = 11
     TOTAL TIME WINDOW      = 44
     STARTING POSITION      = 0.000
     FINAL POSITION         = 5.400
     STEP SIZE USED         = 0.050
     POSITION UNITS         = m
     NOMINAL FREQUENCY      = 250.00
     ANTENNA SEPARATION     = 0.305
     PULSER VOLTAGE         = 100
     NUMBER OF STACKS       = 16
     SURVEY MODE            = Reflection

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 2
                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -4 to 40
                  POSITIONS: 0.000 to 5.400
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000


PLOT LAYOUT PARAMETERS
      TRACE SPACING AND WIDTH: 0.0600 and 0.2500
      TRACE BOTTOM AND TOP: 1.0000  and 9.0000
      MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
      PAGE WIDTH: 10.0000
      BORDER SIZE: 0.000
      PRINTER NAME: LAS300
      SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```

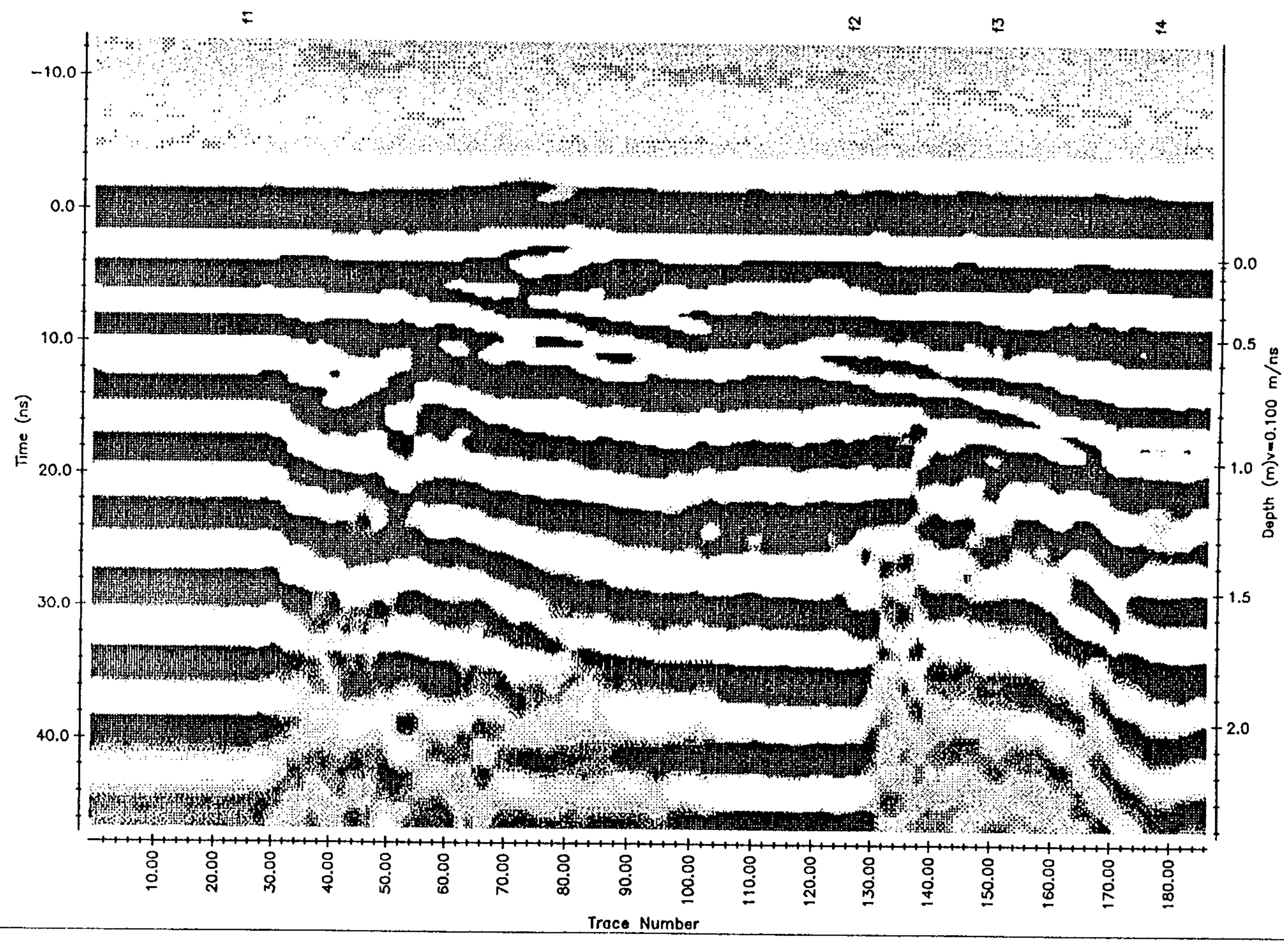


Appendix E
Crystal Gypsum
GPR Records – Buried Contraband Simulant Test

pulseEKKO HEADER PARAMETERS
FILE = s:\COASTG~1\21SEP0~1\CG225GS
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Crystal Gypsum Pile, 225 MHz, Sugar - North Edge of Pile
DATE = 21/09/10
NUMBER OF TRACES = 187
NUMBER OF PTS/TRC = 200
TIMEZERO AT POINT = 44
TOTAL TIME WINDOW = 60
STARTING POSITION = 0.000
FINAL POSITION = 186.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 225.00
ANTENNA SEPARATION = 0.500
PULSER VOLTAGE = 200
NUMBER OF STACKS = 16
SURVEY MODE = Reflection
COLLECTED BY PE1000 - CON: 981119 RX: 981120
TX: 981121 ANT: 971195/96

PROCESSING SELECTED
FILTERS: TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: -13 to 47
POSITIONS: 0.000 to 186.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0600 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS

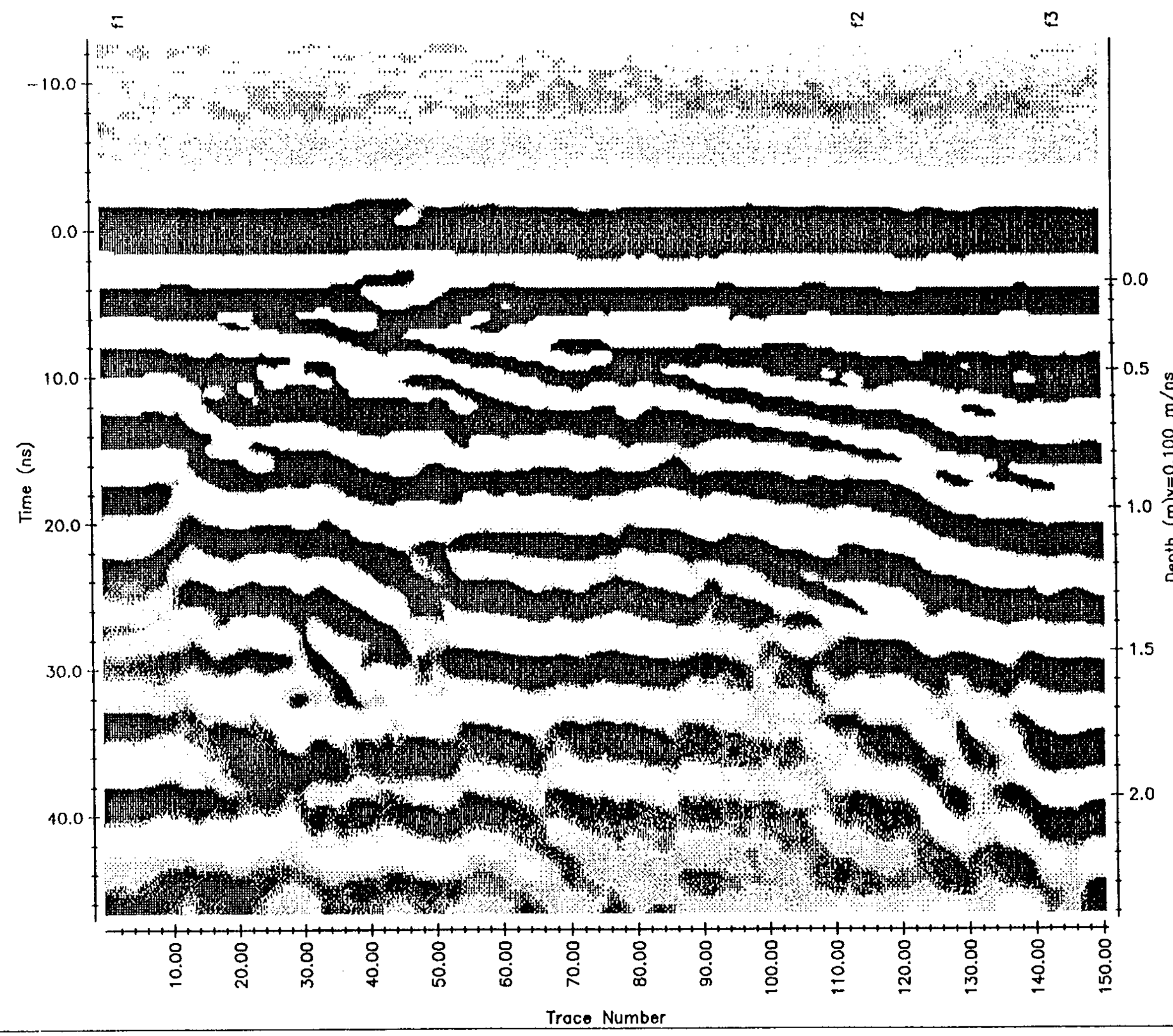
```
FILE  = s:\COASTG~1\21SEP0~1\CG225GS2
JOB#  =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Crystal Gypsum Pile, 225 MHz, Sugar - North Edge of Pile
DATE  = 21/09/10
NUMBER OF TRACES     = 151
NUMBER OF PTS/TRC    = 200
TIMEZERO AT POINT    = 44
TOTAL TIME WINDOW    = 60
STARTING POSITION    = 0.000
FINAL POSITION       = 150.000
STEP SIZE USED       = 1.000
POSITION UNITS       = metres
NOMINAL FREQUENCY    = 225.00
ANTENNA SEPARATION   = 0.500
PULSER VOLTAGE       = 200
NUMBER OF STACKS     = 16
SURVEY MODE          = Reflection
COLLECTED BY PE1000  - CON: 981119 RX: 981120
                       TX: 981121 ANT: 971195/96
```

PROCESSING SELECTED

```
FILTERS:    TRACE STACKING: 2
            POINT STACKING: 2
            TRACE DIFFERENCING: N
            CORRECTION: DEWOW
SELECTION   TIME: -13 to 47
            POSITIONS: 0.000 to 150.000
GAINS:      GAIN TYPE: CONSTANT
            MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

```
TRACE SPACING AND WIDTH: 0.0600 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```

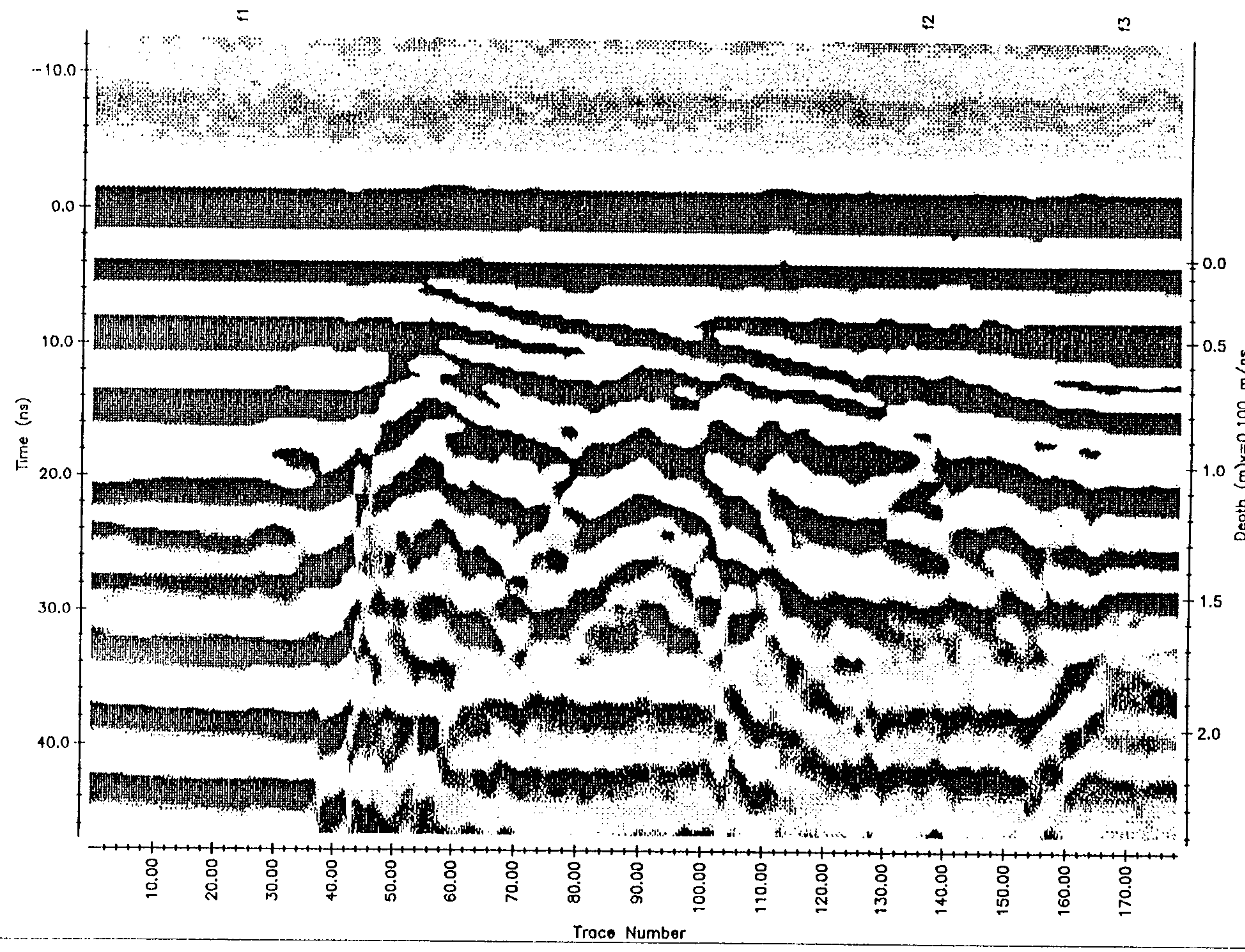


pulseEKKO HEADER PARAMETERS

FILE = s:\COASTG~1\21SEP0~1\CG225GS3
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Crystal Gypsum Pile, 225 MHz, Sugar -- Profile Over Sugar
DATE = 21/09/10
NUMBER OF TRACES = 179
NUMBER OF PTS/TRC = 200
TIMEZERO AT POINT = 44
TOTAL TIME WINDOW = 60
STARTING POSITION = 0.000
FINAL POSITION = 178.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 225.00
ANTENNA SEPARATION = 0.500
PULSER VOLTAGE = 200
NUMBER OF STACKS = 16
SURVEY MODE = Reflection
COLLECTED BY PE1000 -- CON: 981119 RX: 981120
TX: 981121 ANT: 971195/96

PROCESSING SELECTED
FILTERS: TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: -13 to 47
POSITIONS: 0.000 to 178.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0600 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0

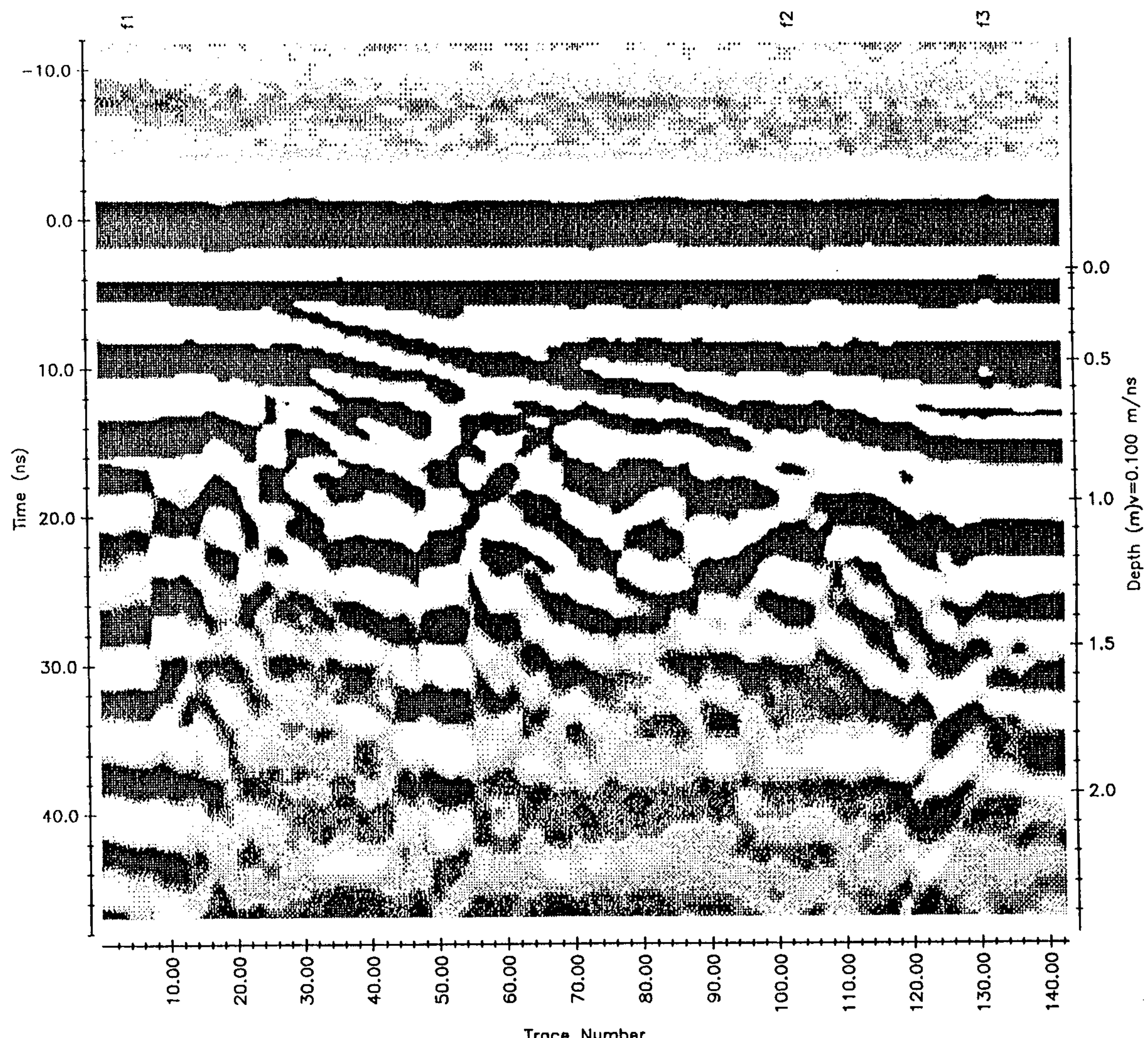


pulseEKKO HEADER PARAMETERS

FILE = s:\COASTG~1\21SEP0~1\CG225GS4
JOB#
TITLE Alabama Shipyard, Bulk Handling Area
TITLE = Crystal Gypsum Pile, 225 MHz, Sugar Profile Over Sugar
DATE = 21/09/10
NUMBER OF TRACES = 143
NUMBER OF PTS/TRC = 200
TIMEZERO AT POINT = 43
TOTAL TIME WINDOW = 60
STARTING POSITION = 0.000
FINAL POSITION = 142.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 225.00
ANTENNA SEPARATION = 0.500
PULSER VOLTAGE = 200
NUMBER OF STACKS = 16
SURVEY MODE = Reflection
COLLECTED BY PE1000 – CON: 981119 RX: 981120
TX: 981121 ANT: 971195/96

PROCESSING SELECTED
FILTERS: TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: −12 to 48
POSITIONS: 0.000 to 142.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

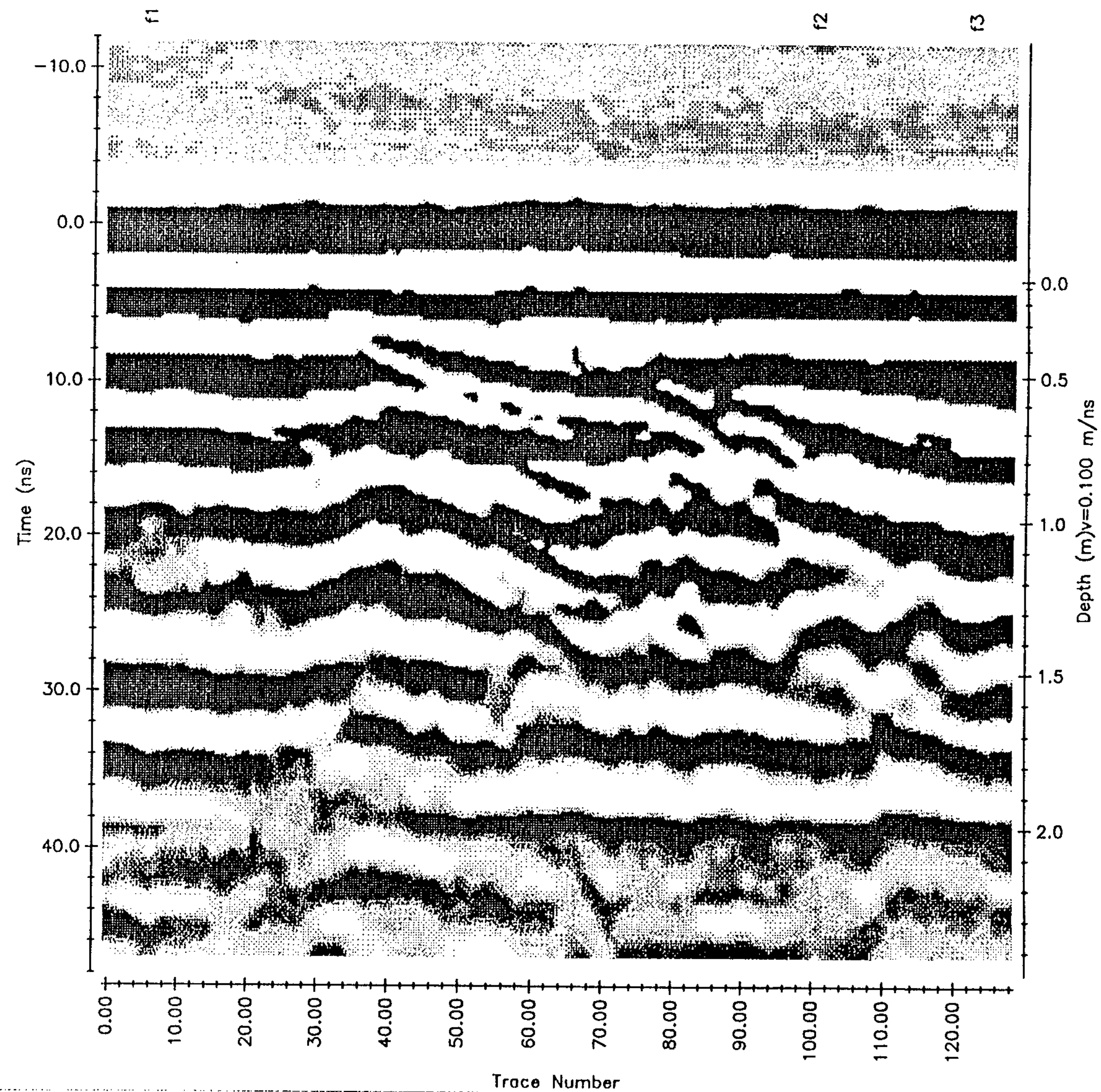
PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0600 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: −0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



```
pulseEKKO HEADER PARAMETERS
     FILE  =  s:\COASTG~1\21SEP0~1\CG225GS5
     JOB#  =
     TITLE  =  Alabama Shipyard, Bulk Handling Area
     TITLE  =  Crystal Gypsum Pile, 225 MHz, Sugar -- South Edge of Pile
     DATE  =  21/09/10
     NUMBER OF TRACES     =  129
     NUMBER OF PTS/TRC    =  200
     TIMEZERO AT POINT    =  43
     TOTAL TIME WINDOW    =  60
     STARTING POSITION    =  0.000
     FINAL POSITION       =  128.000
     STEP SIZE USED       =  1.000
     POSITION UNITS       =  metres
     NOMINAL FREQUENCY    =  225.00
     ANTENNA SEPARATION   =  0.500
     PULSER VOLTAGE       =  200
     NUMBER OF STACKS     =  16
     SURVEY MODE          =  Reflection
     COLLECTED BY PE1000 -- CON: 981119 RX: 981120
                            TX: 981121 ANT: 971195/96

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 2
                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -12 to 48
                  POSITIONS: 0.000 to 128.000
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000

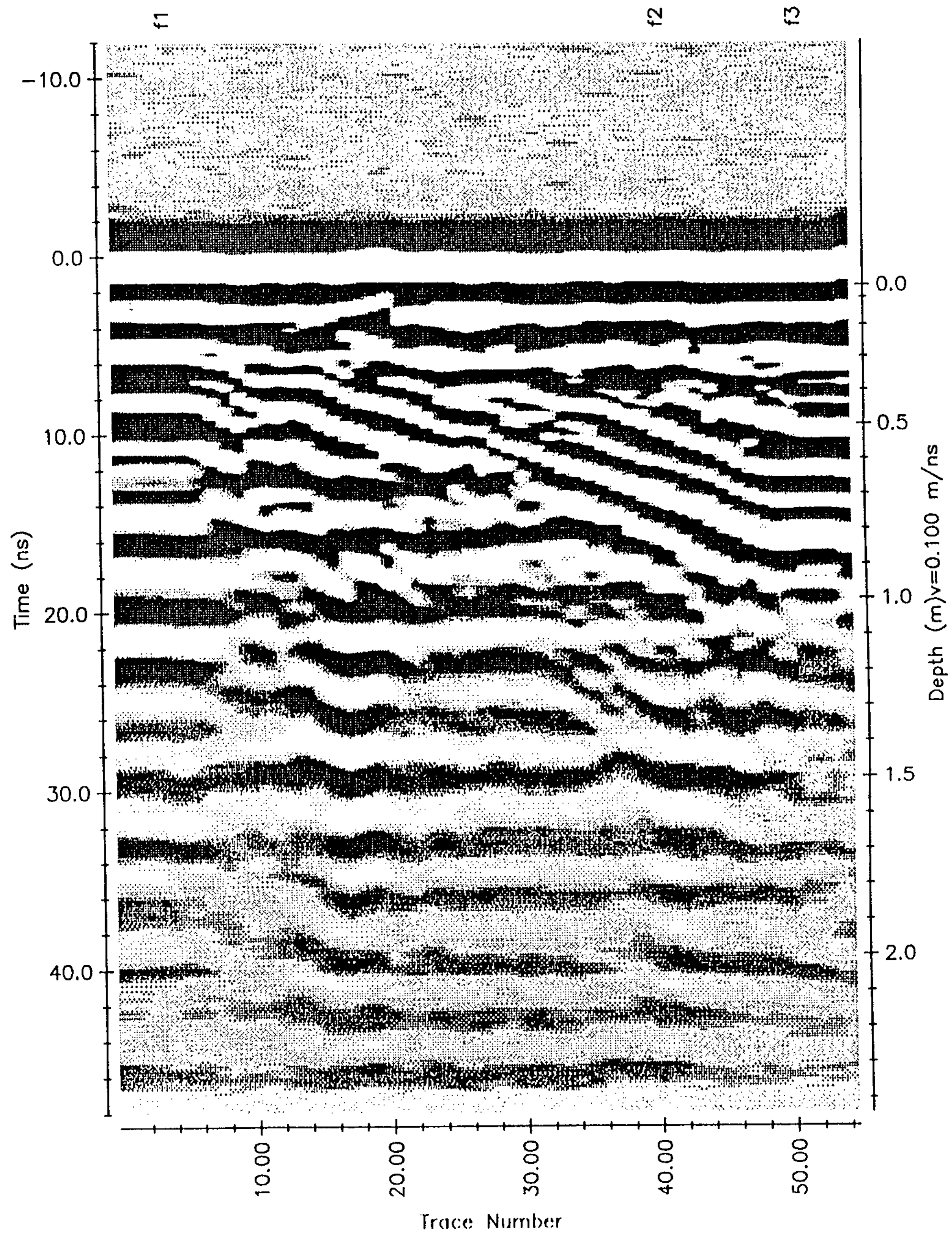

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0600 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE  = s:\COASTG~1\21SEP0~1\CG450GS1
     JOB#  =
     TITLE = Alabama Shipyard, Bulk Handling Area
     TITLE = Crystal Gypsum Pile, 450 MHz, Sugar - North Edge of Sugar
     DATE  = 21/09/10
     NUMBER OF TRACES     = 55
     NUMBER OF PTS/TRC    = 600
     TIMEZERO AT POINT    = 120
     TOTAL TIME WINDOW    = 60
     STARTING POSITION    = 0.000
     FINAL POSITION       = 54.000
     STEP SIZE USED       = 1.000
     POSITION UNITS       = metres
     NOMINAL FREQUENCY    = 450.00
     ANTENNA SEPARATION   = 0.250
     PULSER VOLTAGE       = 200
     NUMBER OF STACKS     = 16
     SURVEY MODE          = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971181/82

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 2
                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -12 to 48
                  POSITIONS: 0.000 to 54.000
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000


PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.1000 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

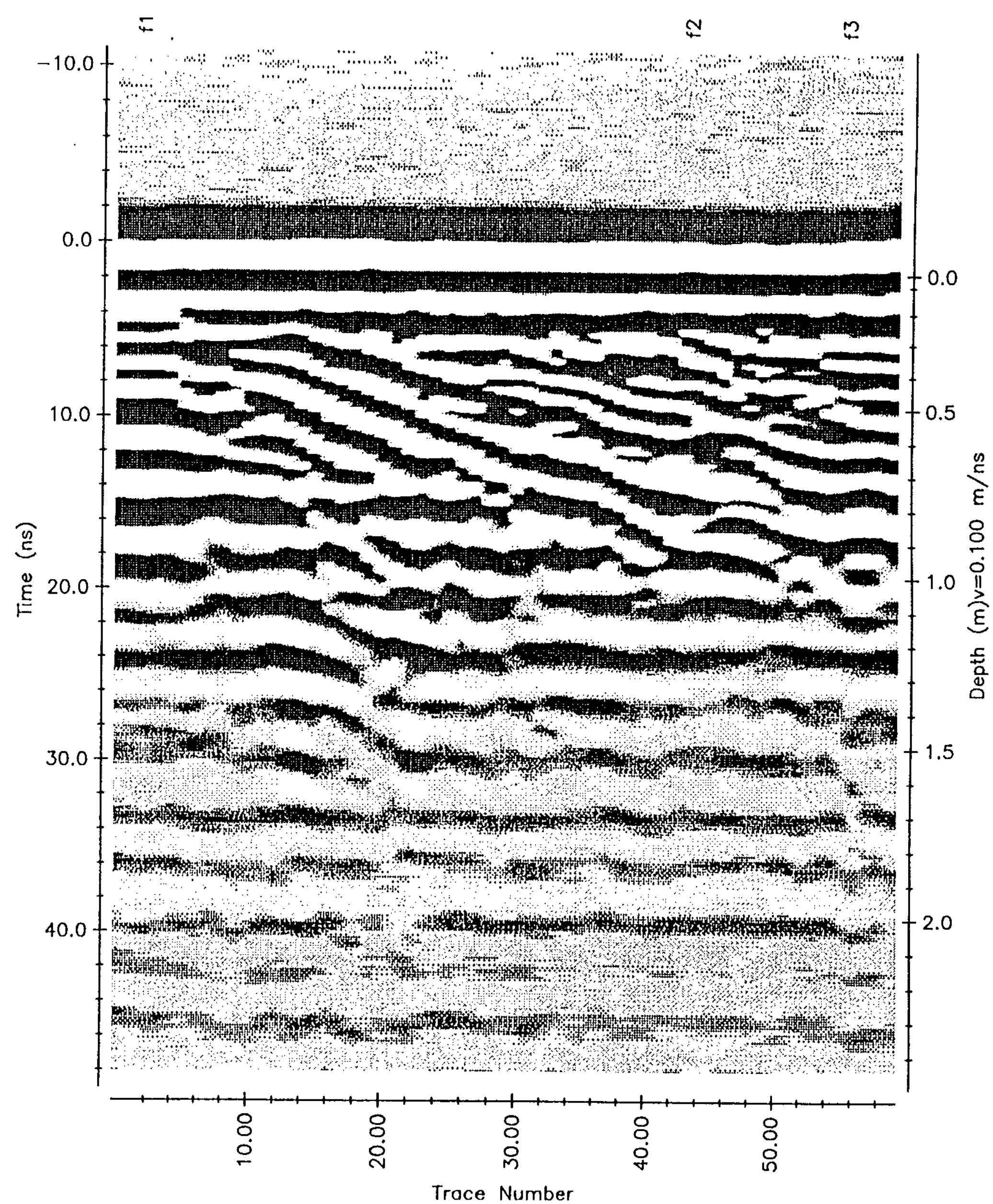
```
     FILE    = s:\COASTG~1\21SEP0~1\CG450GS2
     JOB#    =
     TITLE   = Alabama Shipyard, Bulk Handling Area
     TITLE   = Crystal Gypsum Pile, 450 MHz, Sugar - Profile Over Sugar
     DATE    = 21/09/10
     NUMBER OF TRACES       = 60
     NUMBER OF PTS/TRC      = 600
     TIMEZERO AT POINT      = 119
     TOTAL TIME WINDOW      = 60
     STARTING POSITION      = 0.000
     FINAL POSITION         = 59.000
     STEP SIZE USED         = 1.000
     POSITION UNITS         = metres
     NOMINAL FREQUENCY      = 450.00
     ANTENNA SEPARATION     = 0.250
     PULSER VOLTAGE         = 200
     NUMBER OF STACKS       = 16
     SURVEY MODE            = Reflection
     COLLECTED BY PE1000 -- CON: 981119 RX: 981120
                            TX: 981121 ANT: 971181/82
```

PROCESSING SELECTED

```
     FILTERS:    TRACE STACKING: 2
                 POINT STACKING: 2
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
     SELECTION   TIME: -11 to 49
                 POSITIONS: 0.000 to 59.000
     GAINS:      GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

```
     TRACE SPACING AND WIDTH: 0.1000 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

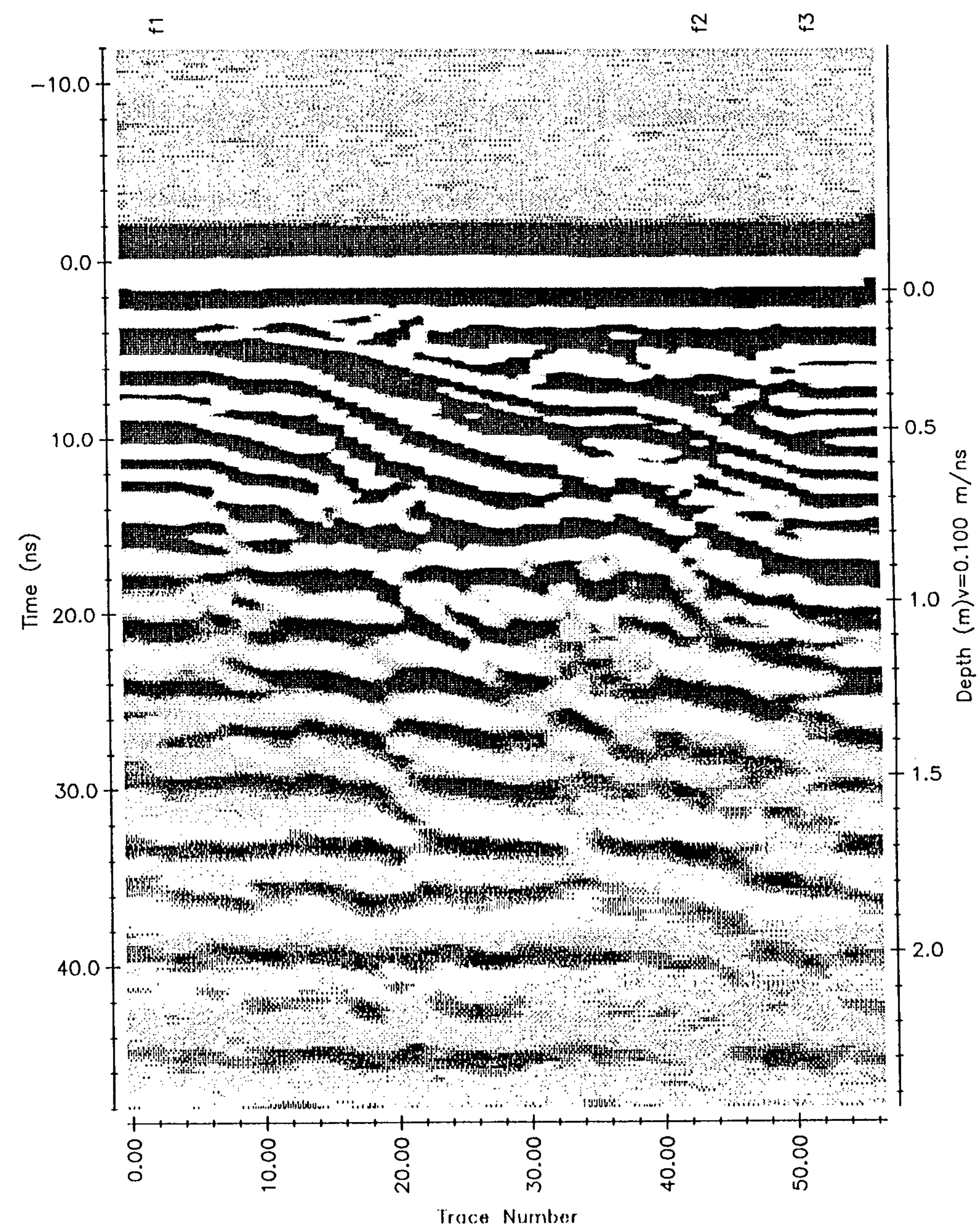
FILE = s:\COASTG~1\21SEP0~1\CG450GS3
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Crystal Gypsum Pile, 450 MHz, Sugar -- South Edge of Pile
DATE = 21/09/10
NUMBER OF TRACES = 57
NUMBER OF PTS/TRC = 600
TIMEZERO AT POINT = 120
TOTAL TIME WINDOW = 60
STARTING POSITION = 0.000
FINAL POSITION = 56.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 450.00
ANTENNA SEPARATION = 0.250
PULSER VOLTAGE = 200
NUMBER OF STACKS = 16
SURVEY MODE = Reflection
COLLECTED BY PE1000 - CON: 981119 RX: 981120
TX: 981121 ANT: 971181,'87

PROCESSING SELECTED

FILTERS: TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: -12 to 48
POSITIONS: 0.000 to 56.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS

TRACE SPACING AND WIDTH: 0.1000 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS

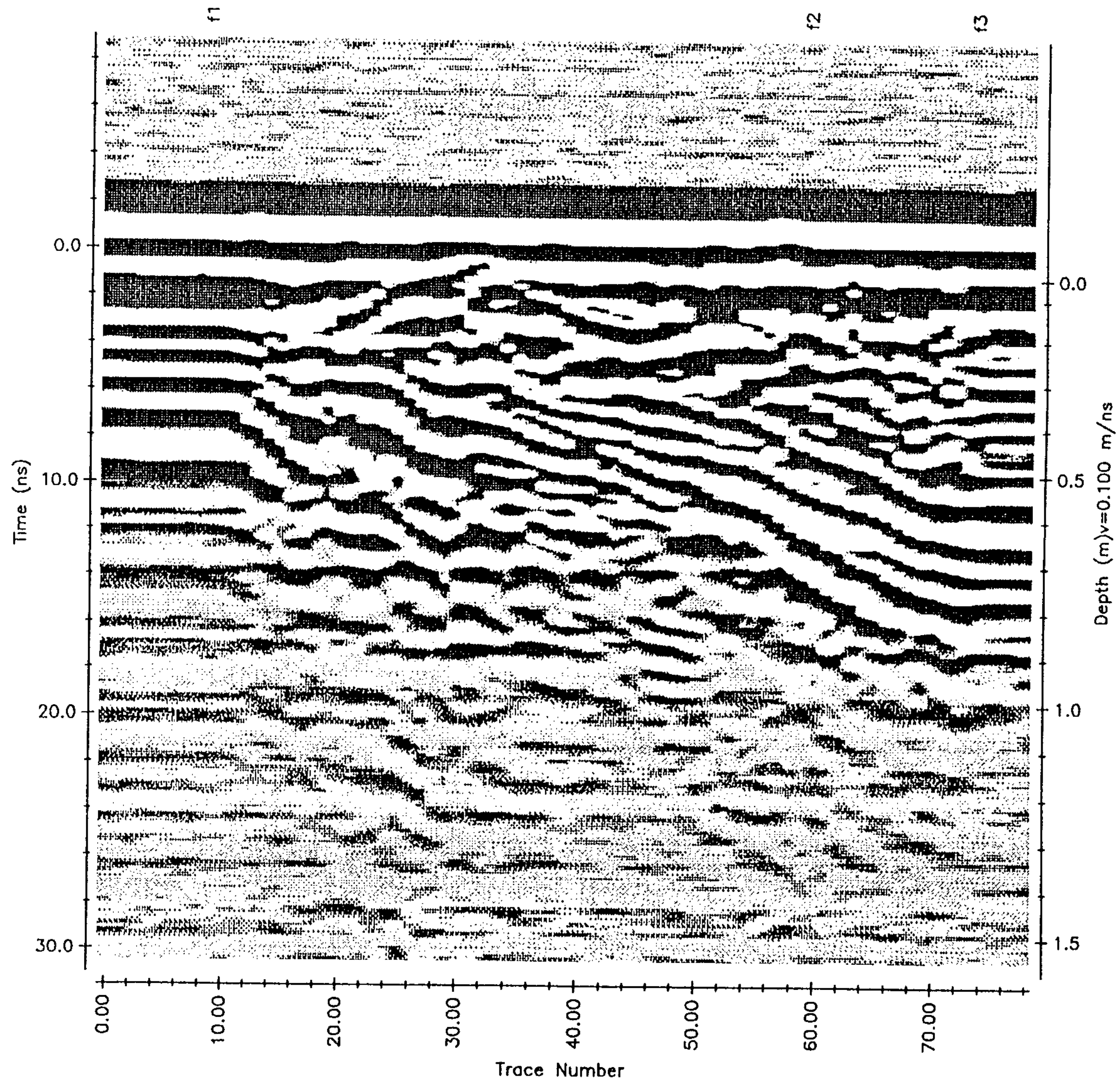
FILE = s:\COASTG~1\21SEP0~1\CG900GS1
JOB#
SITE Alabama Shipyard, Bulk Handling Area
TITLE = Crystal Gypsum Pile, 900 MHz, Sugar - North Edge of Pile
DATE = 21/09/10
NUMBER OF TRACES = 79
NUMBER OF PTS/TRC = 400
TIMEZERO AT POINT = 95
TOTAL TIME WINDOW = 40
STARTING POSITION = 0.000
FINAL POSITION = 78.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 900.00
ANTENNA SEPARATION = 0.170
PULSER VOLTAGE = 200
NUMBER OF STACKS = 4
SURVEY MODE = Reflection
COLLECTED BY PE1000 - CON: 981119 RX: 981120
TX: 981121 ANT: 971258/59

PROCESSING SELECTED

FILTERS: TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: -9 to 31
POSITIONS: 0.000 to 78.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS

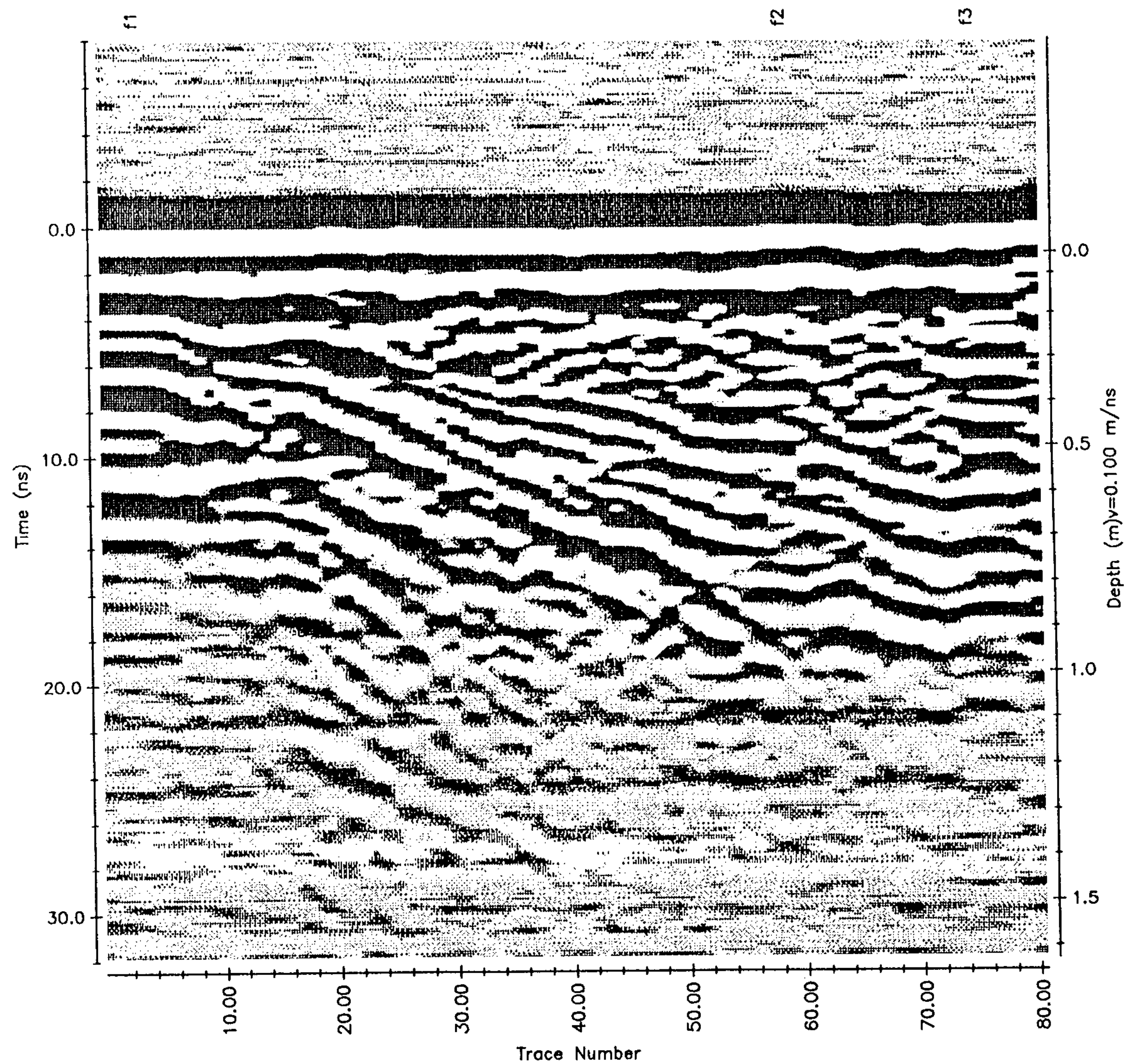
TRACE SPACING AND WIDTH: 0.1000 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS
FILE = s:\COASTC~1\21SEP0~1\CG900652
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Crystal Gypsum Pile, 900 MHz, Sugar – Profile Over Sugar
DATE = 21/09/10
NUMBER OF TRACES = 81
NUMBER OF PTS/TRC = 400
TIMEZERO AT POINT = 81
TOTAL TIME WINDOW = 40
STARTING POSITION = 0.000
FINAL POSITION = 80.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 900.00
ANTENNA SEPARATION = 0.170
PULSER VOLTAGE = 200
NUMBER OF STACKS = 4
SURVEY MODE = Reflection
COLLECTED BY PE1000 - CON: 981119 RX: 981120
TX: 981121 ANT: 971258/59

PROCESSING SELECTED
FILTERS: TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: -8 to 32
POSITIONS: 0.000 to 80.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.1000 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: --0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS

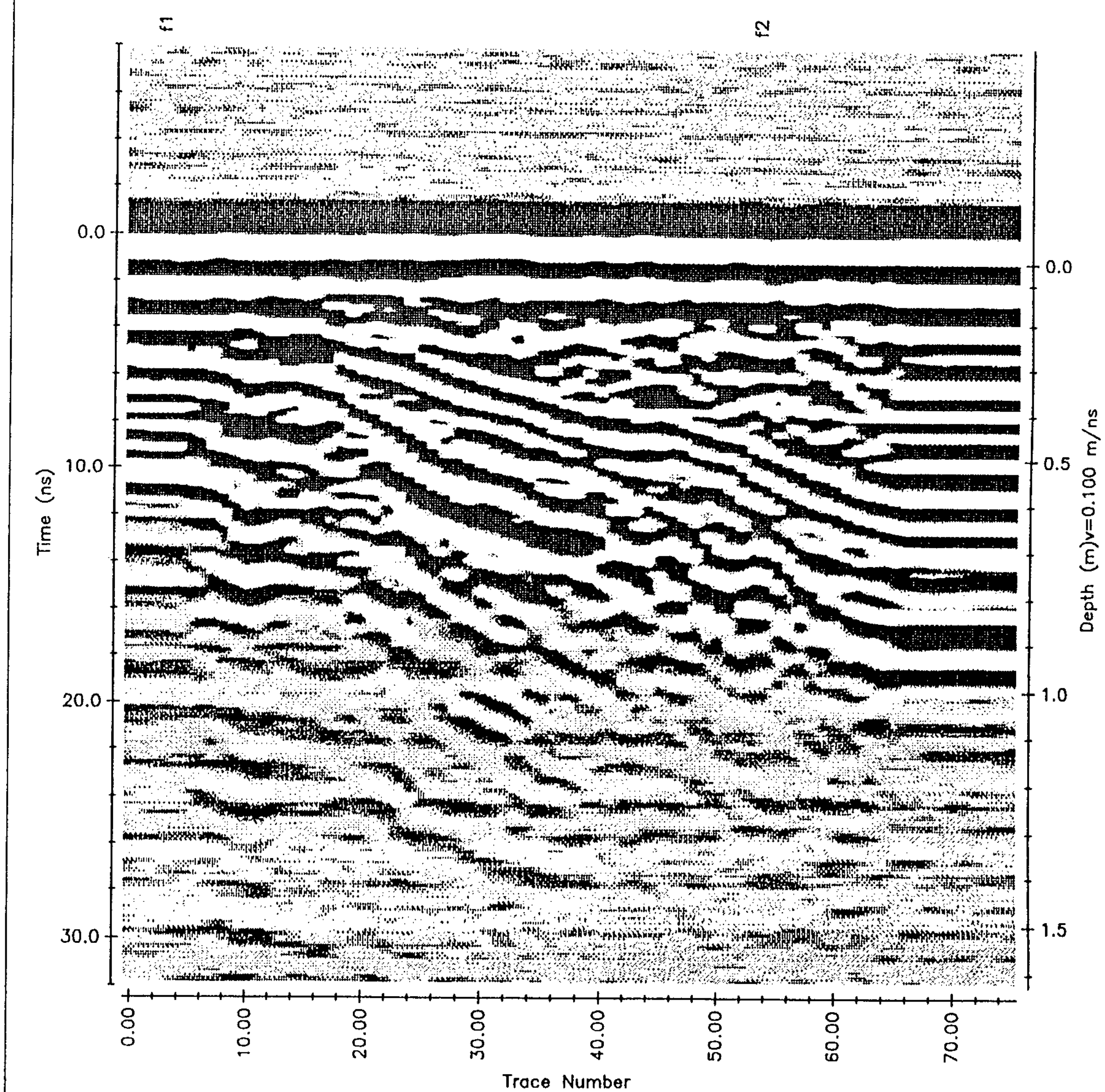
```
    FILE   = s:\COASTG~1\21SEP0~1\CG900GS3
    JOB#   =
    TITLE  = Alabama Shipyard, Bulk Handling Area
    TITLE  = Crystal Gypsum Pile, 900 MHz, Sugar - South Edge of Pile
    DATE   = 21/09/10
    NUMBER OF TRACES      = 76
    NUMBER OF PTS/TRC     = 400
    TIMEZERO AT POINT     = 81
    TOTAL TIME WINDOW     = 40
    STARTING POSITION     = 0.000
    FINAL POSITION        = 75.000
    STEP SIZE USED        = 1.000
    POSITION UNITS        = metres
    NOMINAL FREQUENCY     = 900.00
    ANTENNA SEPARATION    = 0.170
    PULSER VOLTAGE        = 200
    NUMBER OF STACKS      = 4
    SURVEY MODE           = Reflection
    COLLECTED BY PE1000 -- CON: 981119 RX: 981120
                           TX: 981121 ANT: 971258/59
```

PROCESSING SELECTED

```
    FILTERS:     TRACE STACKING: 2
                 POINT STACKING: 2
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
    SELECTION    TIME: -8 to 32
                 POSITIONS: 0.000 to 75.000
    GAINS:       GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

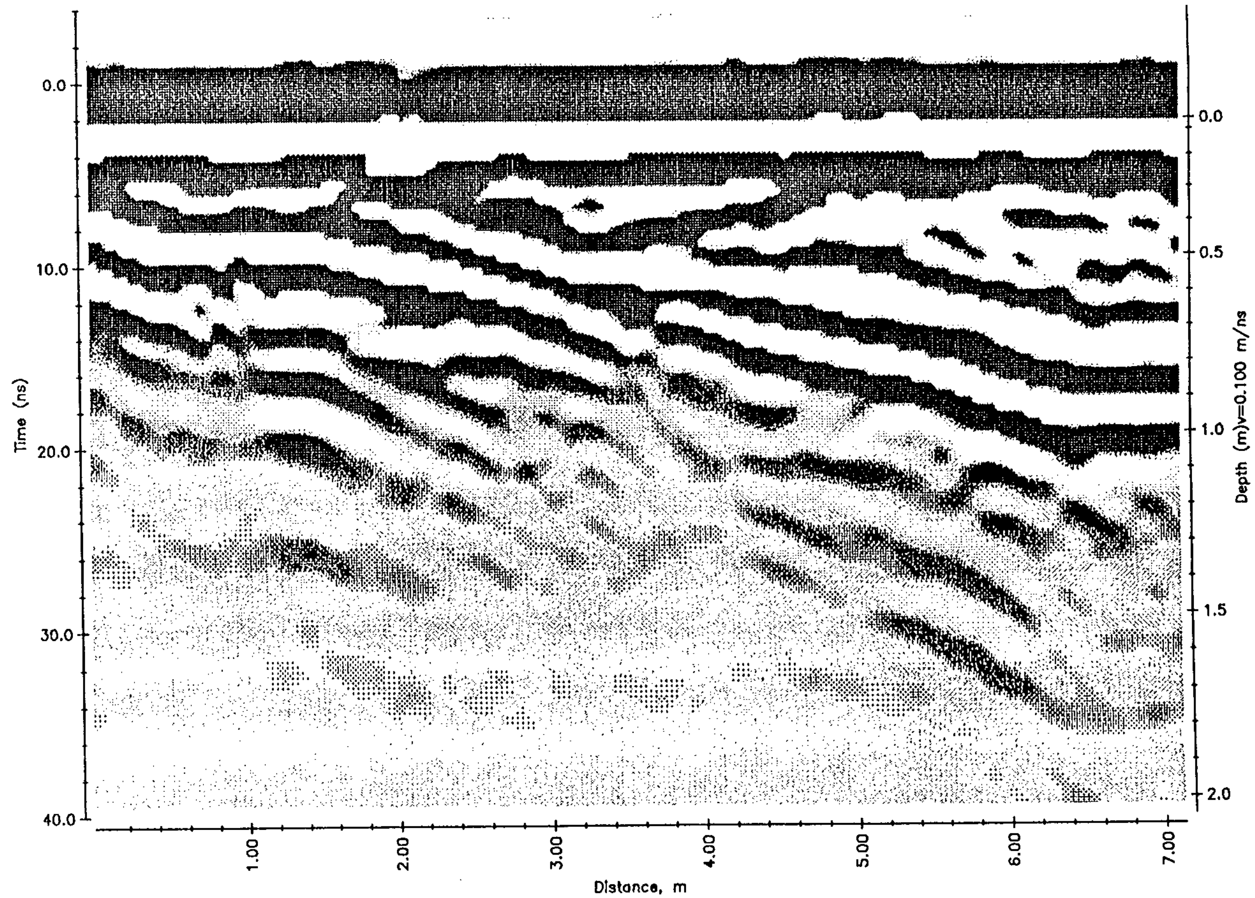
```
    TRACE SPACING AND WIDTH: 0.1000 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
    FILE    = s:\COASTG~1\21SEP0~1\CG250GS0
    JOB#    =
    TITLE   = Alabama Shipyard, Bulk Handling Area
    TITLE   = Crystal Gypsum Pile, 250 MHz, Sugar -- North Edge of Pile
    DATE    = 09/21/20
    NUMBER OF TRACES     = 143
    NUMBER OF PTS/TRC    = 111
    TIMEZERO AT POINT    = 11
    TOTAL TIME WINDOW    = 44
    STARTING POSITION    = 0.000
    FINAL POSITION       = 7.100
    STEP SIZE USED       = 0.050
    POSITION UNITS       = m
    NOMINAL FREQUENCY    = 250.00
    ANTENNA SEPARATION   = 0.305
    PULSER VOLTAGE       = 100
    NUMBER OF STACKS     = 16
    SURVEY MODE          = Reflection

PROCESSING SELECTED
    FILTERS:    TRACE STACKING: 2
                POINT STACKING: 2
                TRACE DIFFERENCING: N
                CORRECTION: DEWOW
    SELECTION   TIME: -4 to 40
                POSITIONS: 0.000 to 7.100
    GAINS:      GAIN TYPE: CONSTANT
                MULTIPLIER: 100.000

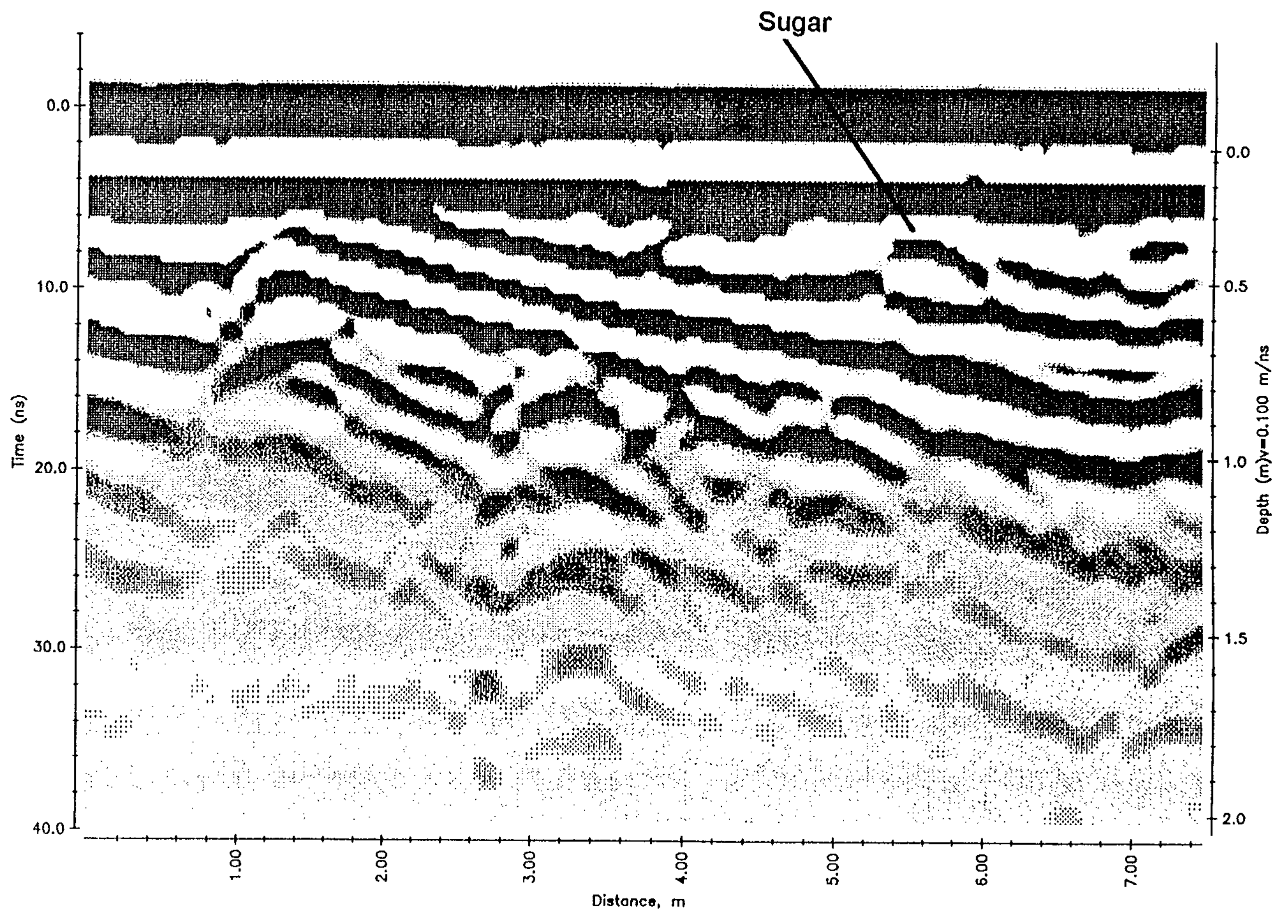
PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.0750 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS
FILE = s:\COASTG~1\21SEP0~1\CG250GS1
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Crystal Gypsum Pile, 250 MHz, Sugar – Profile Over Sugar
DATE = 09/21/20
NUMBER OF TRACES = 150
NUMBER OF PTS/TRC = 111
TIMEZERO AT POINT = 11
TOTAL TIME WINDOW = 44
STARTING POSITION = 0.000
FINAL POSITION = 7.450
STEP SIZE USED = 0.050
POSITION UNITS = m
NOMINAL FREQUENCY = 250.00
ANTENNA SEPARATION = 0.305
PULSER VOLTAGE = 100
NUMBER OF STACKS = 16
SURVEY MODE = Reflection

PROCESSING SELECTED
FILTERS: TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: –4 to 40
POSITIONS: 0.000 to 7.450
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0750 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: –0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS

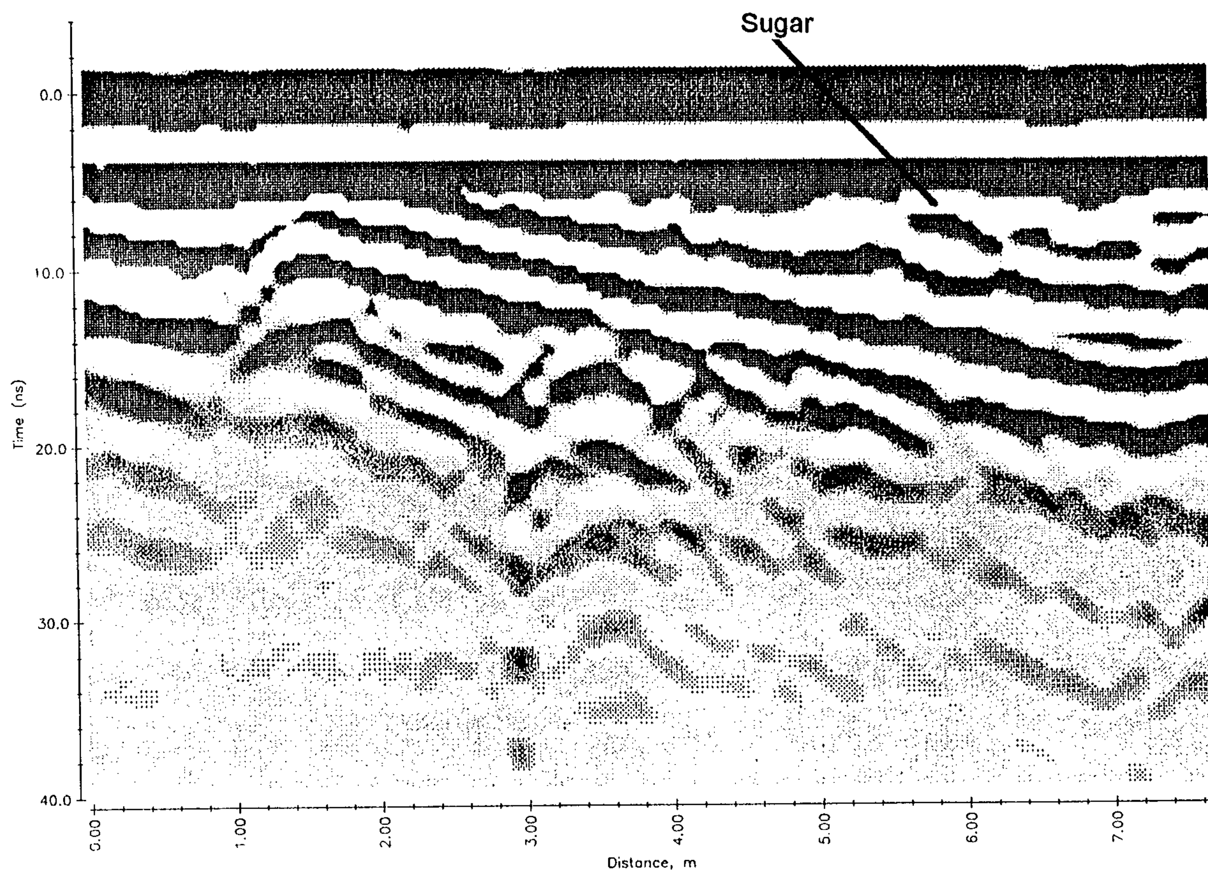
```
FILE   = s:\COASTG~1\21SEPO~1\CG250GS2
JOB#   =
TITLE  = Alabama Shipyard, Bulk Handling Area
TITLE  = Crystal Gypsum Pile, 250 MHz, Sugar - Profile Over Sugar
DATE   = 09/21/20
NUMBER OF TRACES     = 154
NUMBER OF PTS/TRC    = 111
TIMEZERO AT POINT    = 11
TOTAL TIME WINDOW    = 44
STARTING POSITION    = 0.000
FINAL POSITION       = 7.650
STEP SIZE USED       = 0.050
POSITION UNITS       = m
NOMINAL FREQUENCY    = 250.00
ANTENNA SEPARATION   = 0.305
PULSER VOLTAGE       = 100
NUMBER OF STACKS     = 16
SURVEY MODE          = Reflection
```

PROCESSING SELECTED

```
FILTERS:    TRACE STACKING: 2
            POINT STACKING: 2
            TRACE DIFFERENCING: N
            CORRECTION: DEWOW
SELECTION   TIME: -4 to 40
            POSITIONS: 0.000 to 7.650
GAINS:      GAIN TYPE: CONSTANT
            MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

```
TRACE SPACING AND WIDTH: 0.0750 and 0.2500
TRACE BOTTOM AND TOP: 1.0000  and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



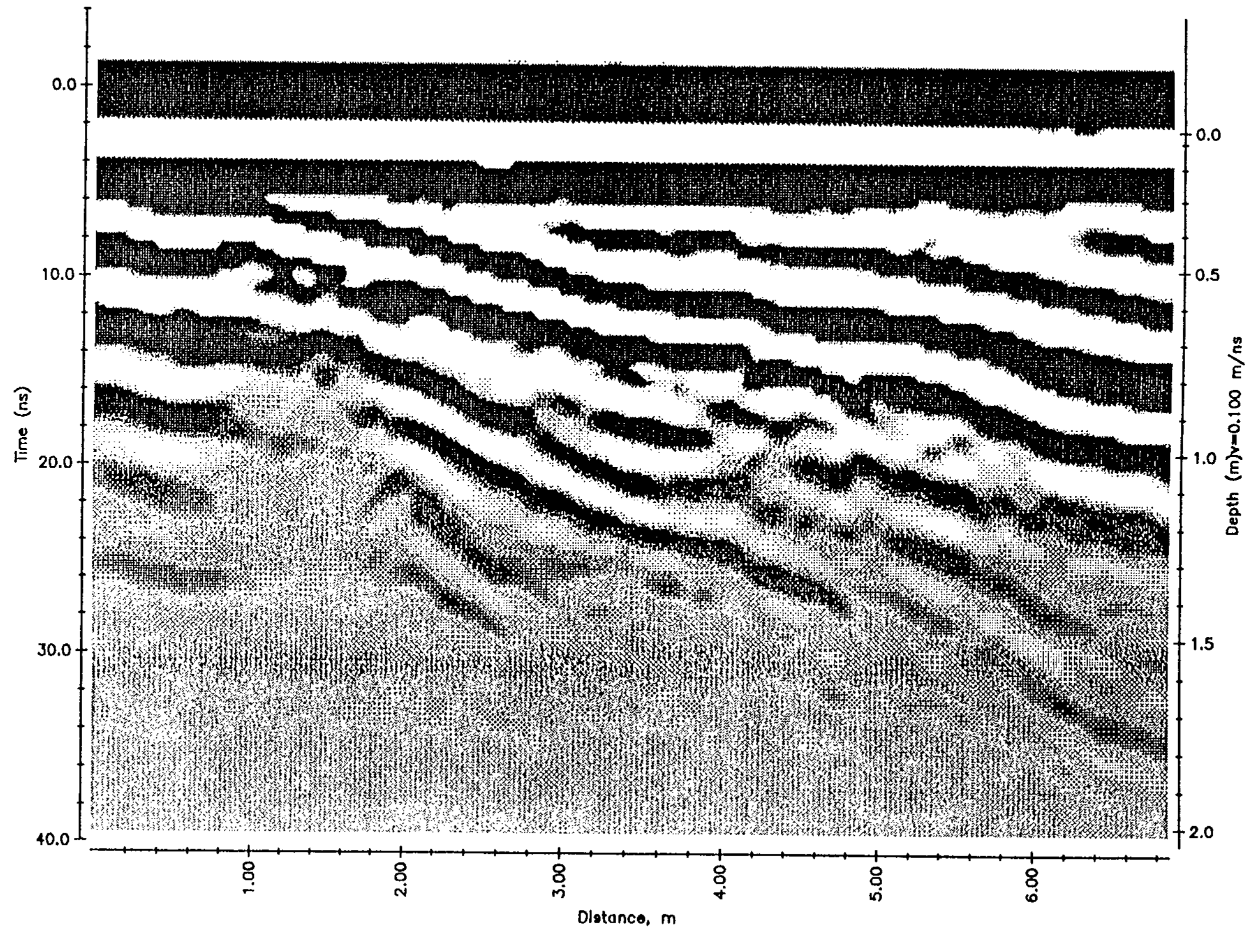
pulseEKKO HEADER PARAMETERS

FILE	=	s:\COASTG~1\21SEP0~1\CG250GS3
JOB#	=	
TITLE	=	Alabama Shipyard, Bulk Handling Area
TITLE	=	Crystal Gypsum Pile, 250 MHz, Sugar – South Edge of Pile
DATE	=	09/21/20
NUMBER OF TRACES	=	138
NUMBER OF PTS/TRC	=	111
TIMEZERO AT POINT	=	11
TOTAL TIME WINDOW	=	44
STARTING POSITION	=	0.000
FINAL POSITION	=	6.850
STEP SIZE USED	=	0.050
POSITION UNITS	=	m
NOMINAL FREQUENCY	=	250.00
ANTENNA SEPARATION	=	0.305
PULSER VOLTAGE	=	100
NUMBER OF STACKS	=	16
SURVEY MODE	=	Reflection

PROCESSING SELECTED

FILTERS:	TRACE STACKING: 2
	POINT STACKING: 2
	TRACE DIFFERENCING: N
	CORRECTION: DEWOW
SELECTION	TIME: -4 to 40
	POSITIONS: 0.000 to 6.850
GAINS:	GAIN TYPE: CONSTANT
	MULTIPLIER: 100.000

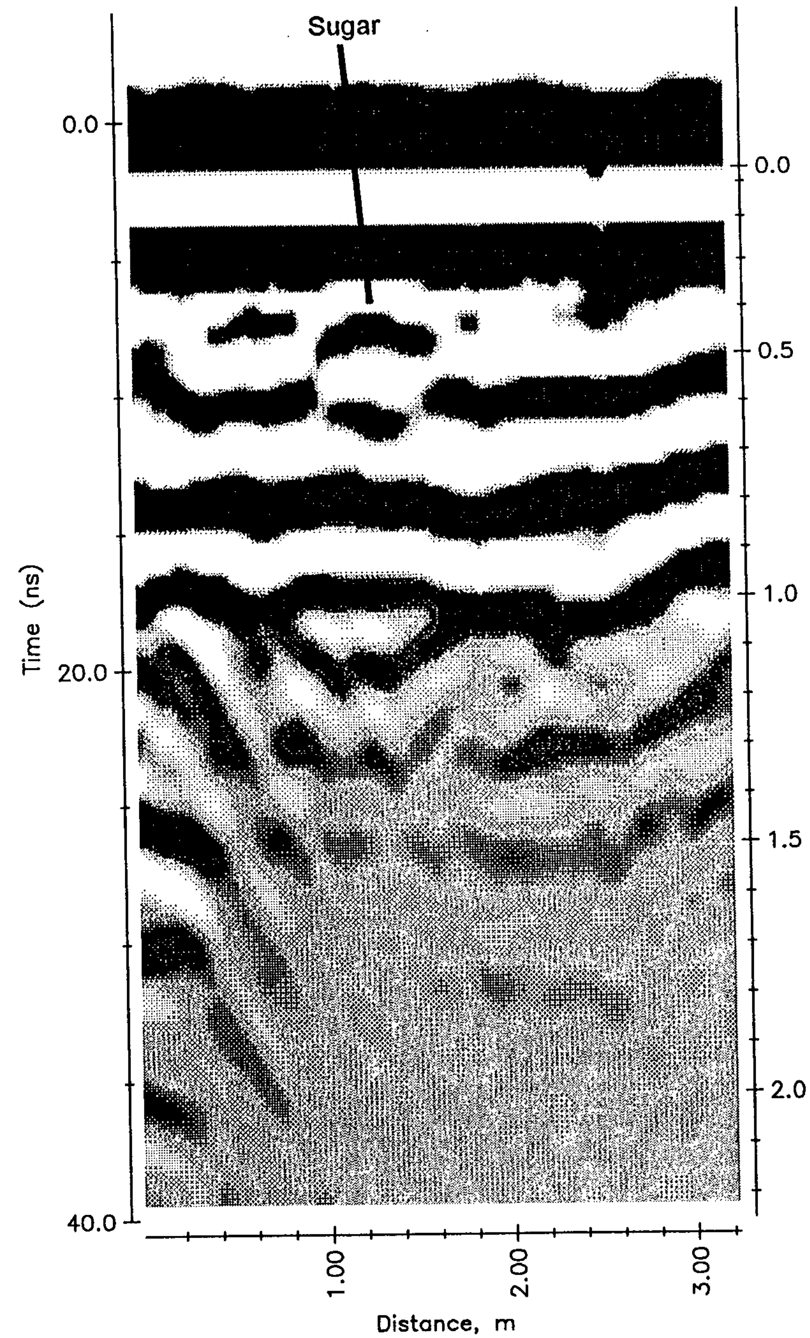
PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0750 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



```
pulseEKKO HEADER PARAMETERS
    FILE  = s:\COASTG~1\21SEP0~1\CG250GS4
    JOB#  =
    TITLE = Alabama Shipyard, Bulk Handling Area
    TITLE = Crystal Gypsum Pile, 250 MHz, Sugar - N/S Profile Over Sugar
    DATE  = 09/21/20
    NUMBER OF TRACES      = 65
    NUMBER OF PTS/TRC     = 111
    TIMEZERO AT POINT     = 11
    TOTAL TIME WINDOW     = 44
    STARTING POSITION     = 0.000
    FINAL POSITION        = 3.200
    STEP SIZE USED        = 0.050
    POSITION UNITS        = m
    NOMINAL FREQUENCY     = 250.00
    ANTENNA SEPARATION    = 0.305
    PULSER VOLTAGE        = 100
    NUMBER OF STACKS      = 16
    SURVEY MODE           = Reflection

PROCESSING SELECTED
    FILTERS:     TRACE STACKING: 1
                 POINT STACKING: 5
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
    SELECTION    TIME: -4 to 40
                 POSITIONS: 0.000 to 3.200
    GAINS:       GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000


PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.0600 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```

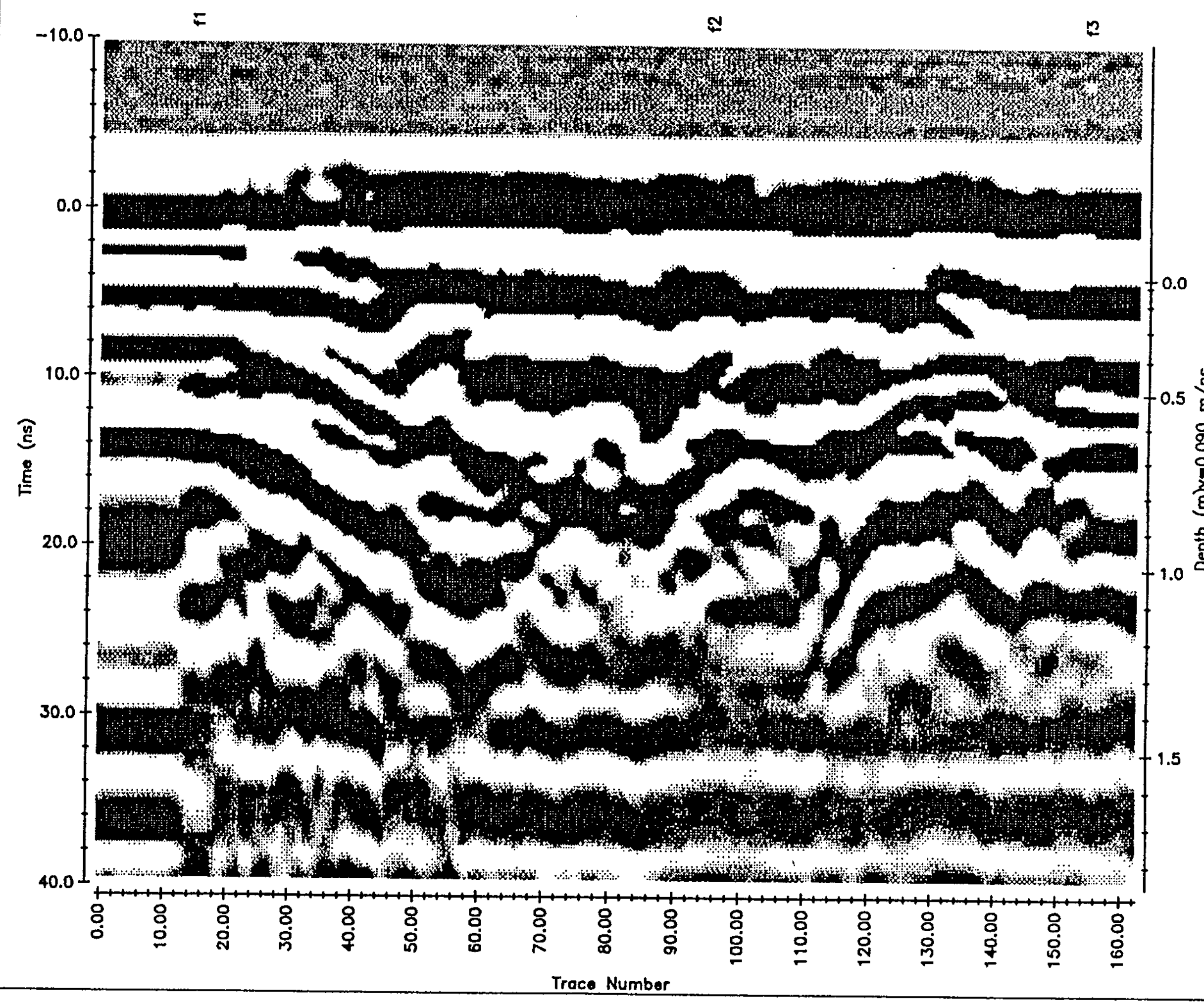


Appendix F
Powdered Gypsum
GPR Records – Buried Contraband Simulant Test

```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\21SEP0~1\CG225PS1
     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Powered Gypsum Pile, 225 MHz, Sugar - West Edge of Pile
     DATE   = 21/09/10
     NUMBER OF TRACES     = 163
     NUMBER OF PTS/TRC    = 166
     TIMEZERO AT POINT    = 34
     TOTAL TIME WINDOW    = 50
     STARTING POSITION    = 0.000
     FINAL POSITION       = 162.000
     STEP SIZE USED       = 1.000
     POSITION UNITS       = metres
     NOMINAL FREQUENCY    = 225.00
     ANTENNA SEPARATION   = 0.500
     PULSER VOLTAGE       = 200
     NUMBER OF STACKS     = 4
     SURVEY MODE          = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971195/96

PROCESSING SELECTED
     FILTERS:      TRACE STACKING: 2
                   POINT STACKING: 2
                   TRACE DIFFERENCING: N
                   CORRECTION: DEWOW
     SELECTION     TIME: -10 to 40
                   POSITIONS: 0.000 to 162.000
     GAINS:        GAIN TYPE: CONSTANT
                   MULTIPLIER: 100.000

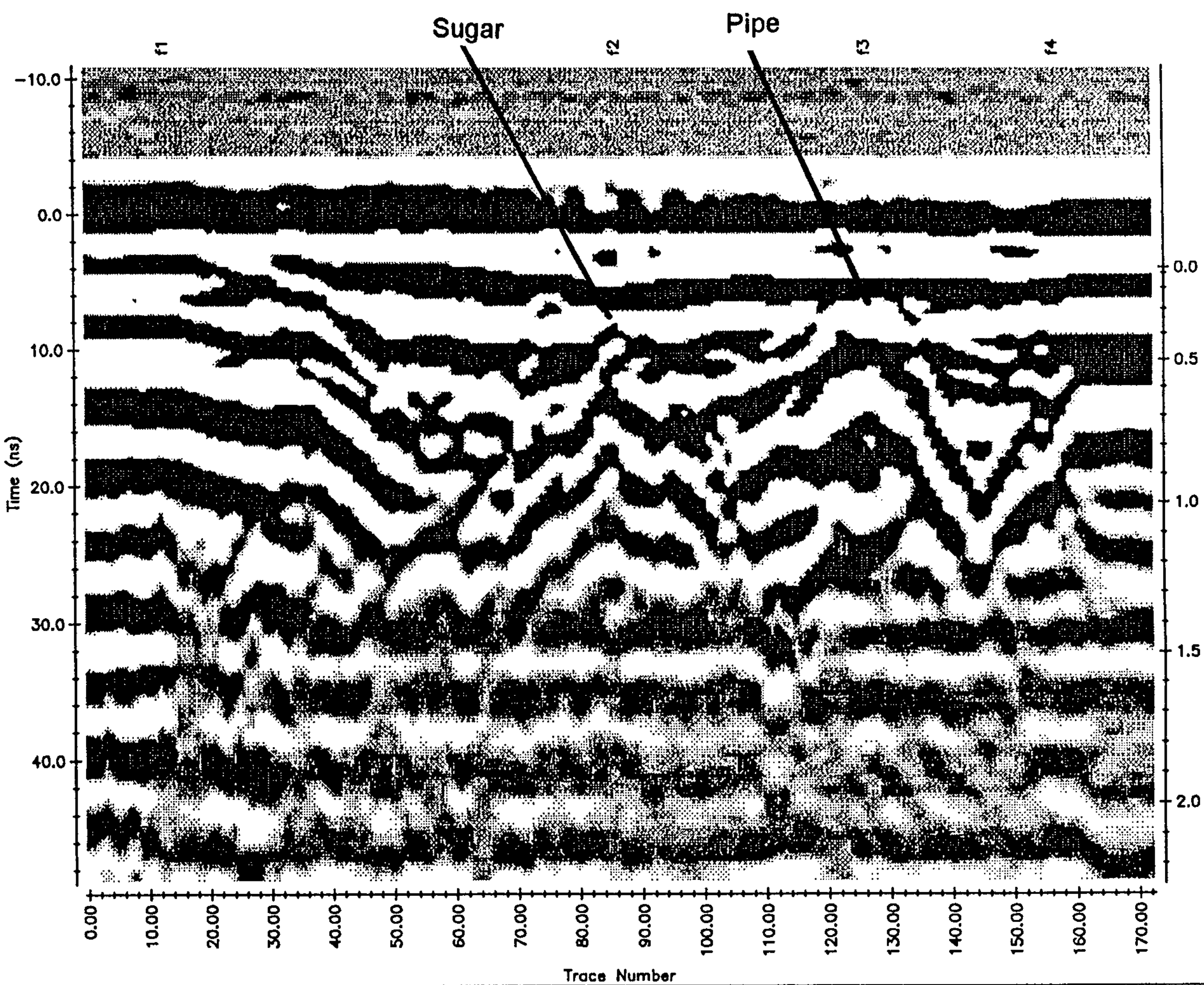

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0600 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000 and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS
FILE = s:\COASTG~1\21SEP0~1\CG225PS2
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Powered Gypsum Pile, 225 MHz, Sugar – Profile Over Sugar
DATE = 21/09/10
NUMBER OF TRACES = 173
NUMBER OF PTS/TRC = 200
TIMEZERO AT POINT = 37
TOTAL TIME WINDOW = 60
STARTING POSITION = 0.000
FINAL POSITION = 172.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 225.00
ANTENNA SEPARATION = 0.500
PULSER VOLTAGE = 200
NUMBER OF STACKS = 4
SURVEY MODE = Reflection
COLLECTED BY PE1000 – CON: 981119 RX: 981120
TX: 981121 ANT: 971195/96

PROCESSING SELECTED
FILTERS: TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: −11 to 49
POSITIONS: 0.000 to 172.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

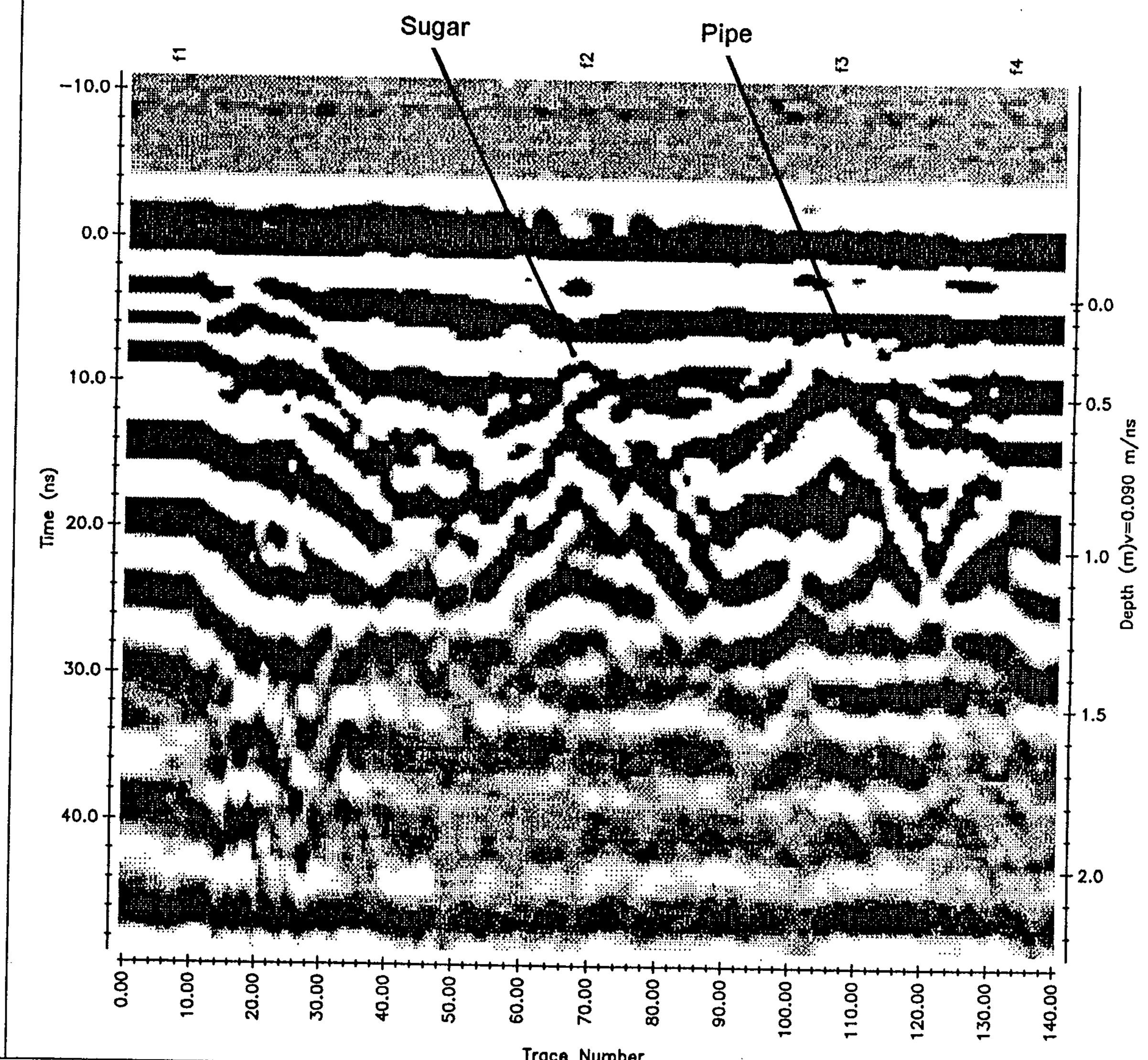
PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0600 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: −0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\21SEP0~1\CG225PS3
     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Powered Gypsum Pile, 225 MHz, Sugar - Profile Over Sugar
     DATE   = 21/09/10
     NUMBER OF TRACES      = 141
     NUMBER OF PTS/TRC     = 200
     TIMEZERO AT POINT     = 37
     TOTAL TIME WINDOW     = 60
     STARTING POSITION     = 0.000
     FINAL POSITION        = 140.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 225.00
     ANTENNA SEPARATION    = 0.500
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 4
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971195/96

PROCESSING SELECTED
     FILTERS:    TRACE STACKING: 2
                 POINT STACKING: 2
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
     SELECTION   TIME: -11 to 49
                 POSITIONS: 0.000 to 140.000
     GAINS:      GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000


PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0600 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

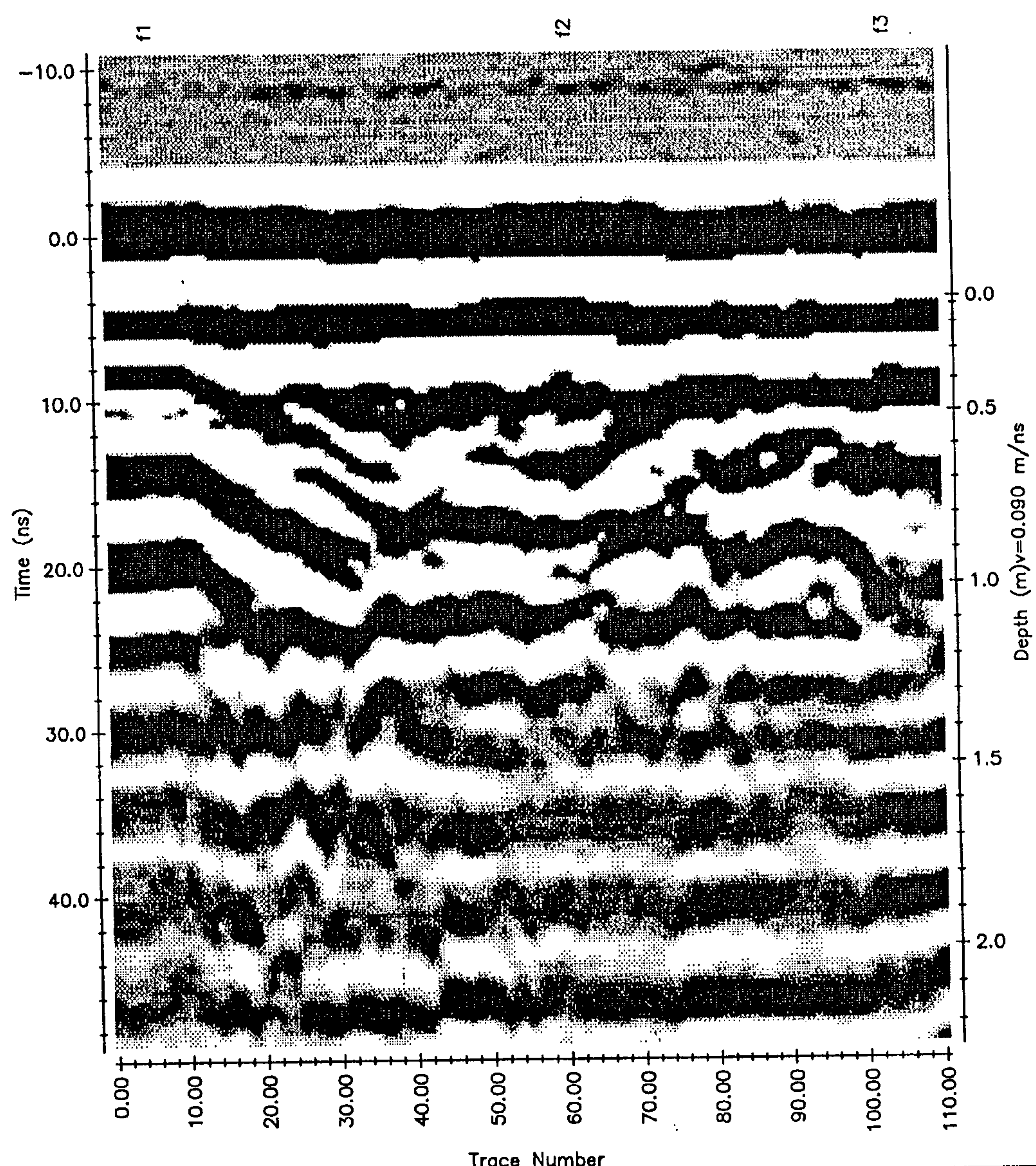
```
FILE    = s:\COASTG~1\21SEP0~1\CG225PS4
JOB#    =
TITLE   = Alabama Shipyard, Bulk Handling Area
TITLE   = Powered Gypsum Pile, 225 MHz, Sugar - East Edge of Pile
DATE    = 21/09/10
NUMBER OF TRACES      = 111
NUMBER OF PTS/TRC     = 200
TIMEZERO AT POINT     = 37
TOTAL TIME WINDOW     = 60
STARTING POSITION     = 0.000
FINAL POSITION        = 110.000
STEP SIZE USED        = 1.000
POSITION UNITS        = metres
NOMINAL FREQUENCY     = 225.00
ANTENNA SEPARATION    = 0.500
PULSER VOLTAGE        = 200
NUMBER OF STACKS      = 4
SURVEY MODE           = Reflection
COLLECTED BY PE1000 - CON: 981119 RX: 981120
                      TX: 981121 ANT: 971195/96
```

PROCESSING SELECTED

```
FILTERS:    TRACE STACKING: 2
            POINT STACKING: 2
            TRACE DIFFERENCING: N
            CORRECTION: DEWOW
SELECTION   TIME: -11 to 49
            POSITIONS: 0.000 to 110.000
GAINS:      GAIN TYPE: CONSTANT
            MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

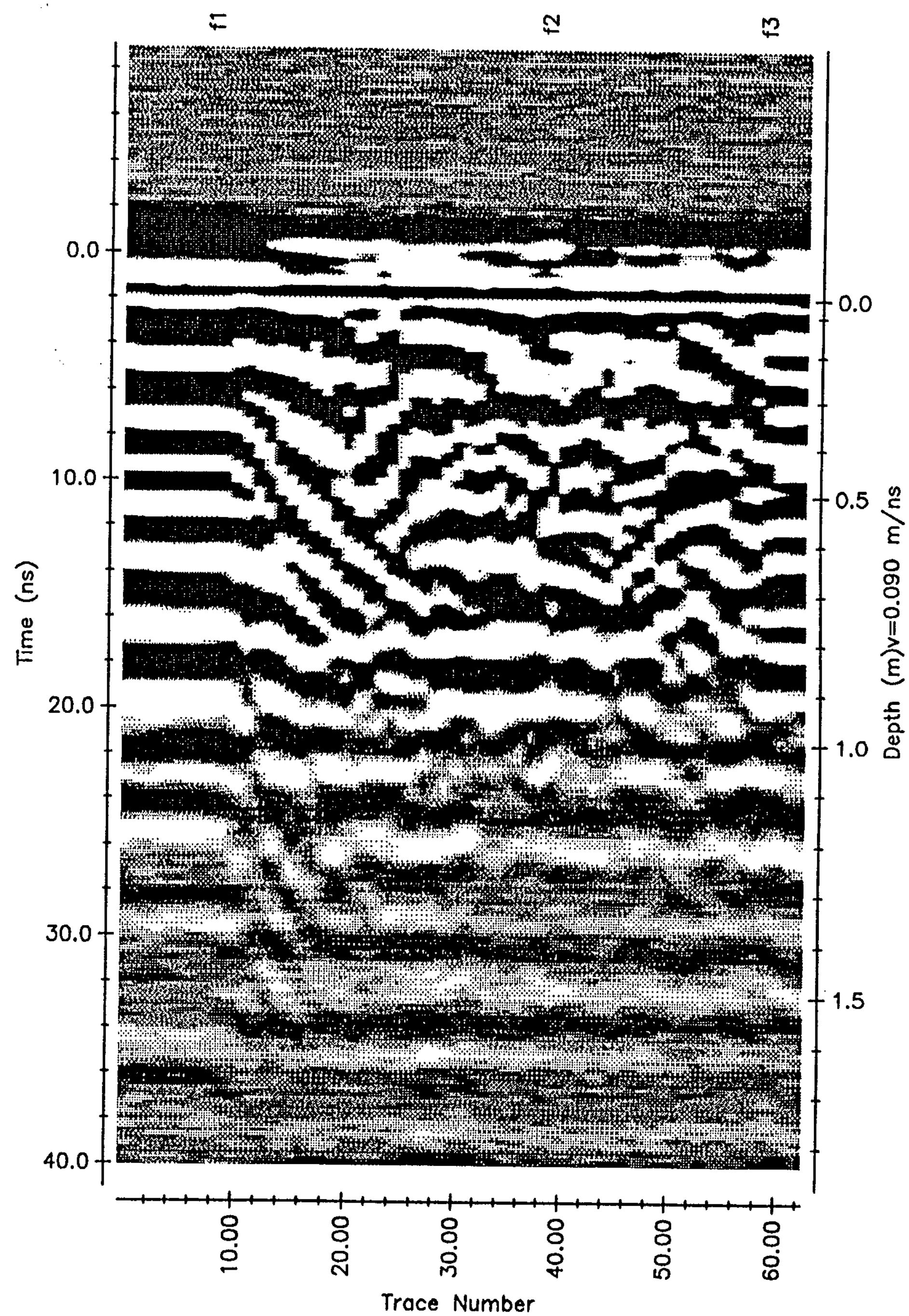
```
TRACE SPACING AND WIDTH: 0.0600 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\21SEP0~1\CG450PS1
     JOB#  =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Powered Gypsum Pile, 450 MHz, Sugar - West Edge of Pile
     DATE  = 21/09/10
     NUMBER OF TRACES      = 63
     NUMBER OF PTS/TRC     = 500
     TIMEZERO AT POINT     = 99
     TOTAL TIME WINDOW     = 50
     STARTING POSITION     = 0.000
     FINAL POSITION        = 62.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 450.00
     ANTENNA SEPARATION    = 0.250
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 4
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971181/82

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 2
                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -9 to 41
                  POSITIONS: 0.000 to 62.000
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0750 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```

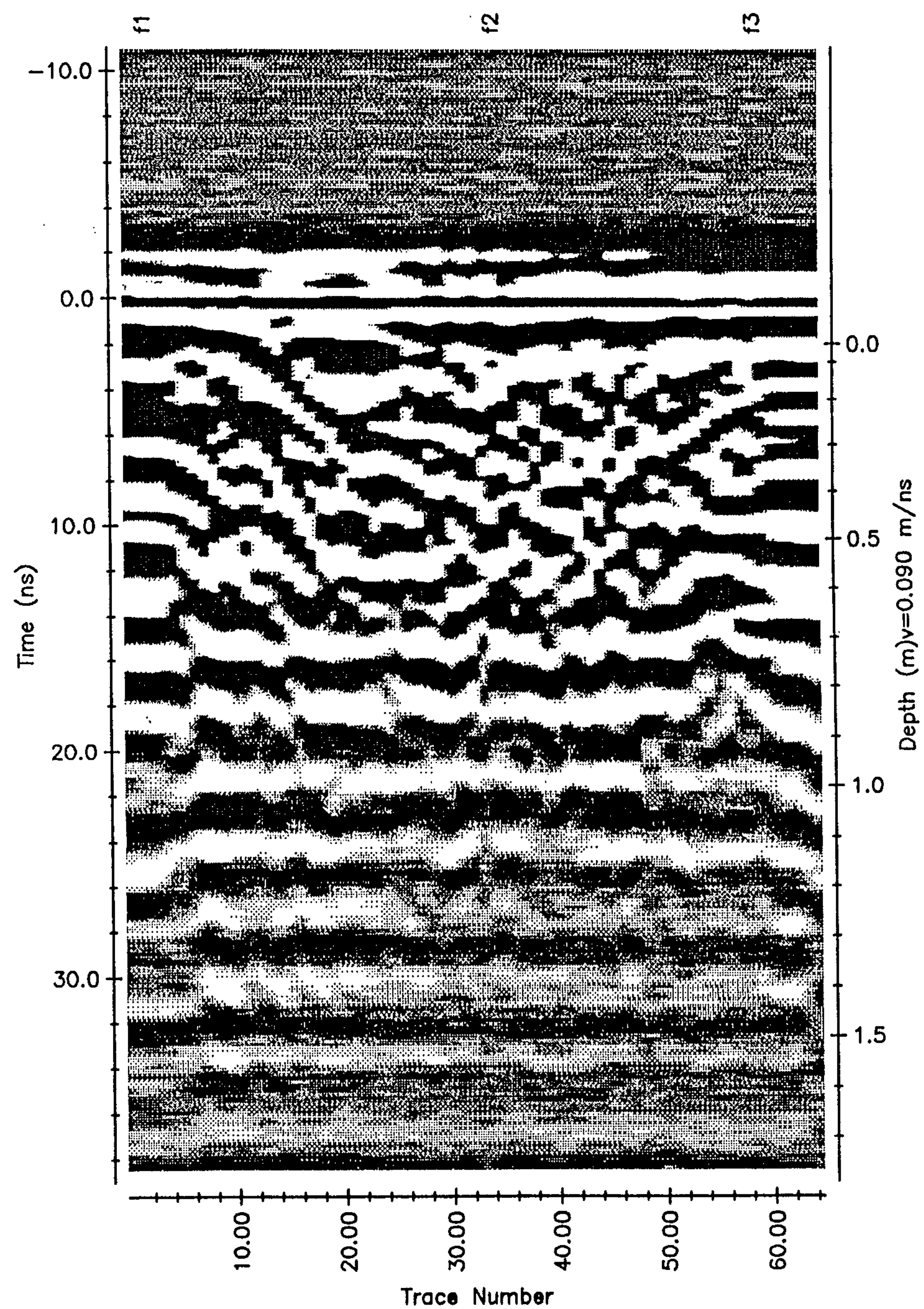


pulseEKKO HEADER PARAMETERS

```
     FILE   = s:\COASTG~1\21SEP0~1\CG450PS2
     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Powered Gypsum Pile, 450 MHz, Sugar' - Profile Over Sugar
     DATE   = 21/09/10
     NUMBER OF TRACES      = 65
     NUMBER OF PTS/TRC     = 500
     TIMEZERO AT POINT     = 115
     TOTAL TIME WINDOW     = 50
     STARTING POSITION     = 0.000
     FINAL POSITION        = 64.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 450.00
     ANTENNA SEPARATION    = 0.250
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 4
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971181/82

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 2
                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -11 to 39
                  POSITIONS: 0.000 to 64.000
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000

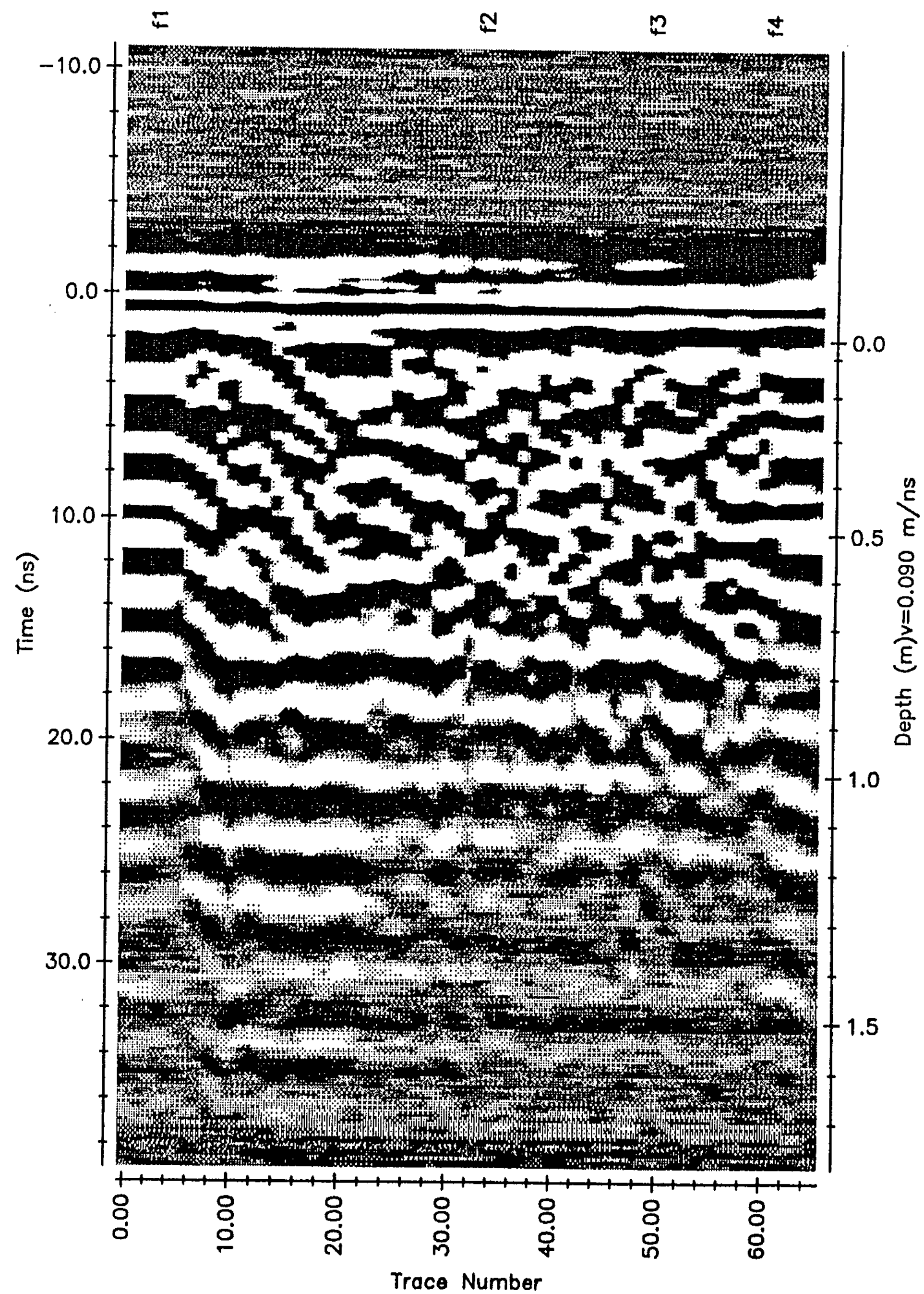
PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0750 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\21SEP0~1\CG450PS3
     JOB#  =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Powered Gypsum Pile, 450 MHz, Sugar' - Profile Over Sugar
     DATE   = 21/09/10
     NUMBER OF TRACES      = 66
     NUMBER OF PTS/TRC     = 500
     TIMEZERO AT POINT     = 110
     TOTAL TIME WINDOW     = 50
     STARTING POSITION     = 0.000
     FINAL POSITION        = 65.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 450.00
     ANTENNA SEPARATION    = 0.250
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 4
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971181/82

PROCESSING SELECTED
     FILTERS:      TRACE STACKING: 2
                   POINT STACKING: 2
                   TRACE DIFFERENCING: N
                   CORRECTION: DEWOW
     SELECTION     TIME: -11 to 39
                   POSITIONS: 0.000 to 65.000
     GAINS:        GAIN TYPE: CONSTANT
                   MULTIPLIER: 100.000

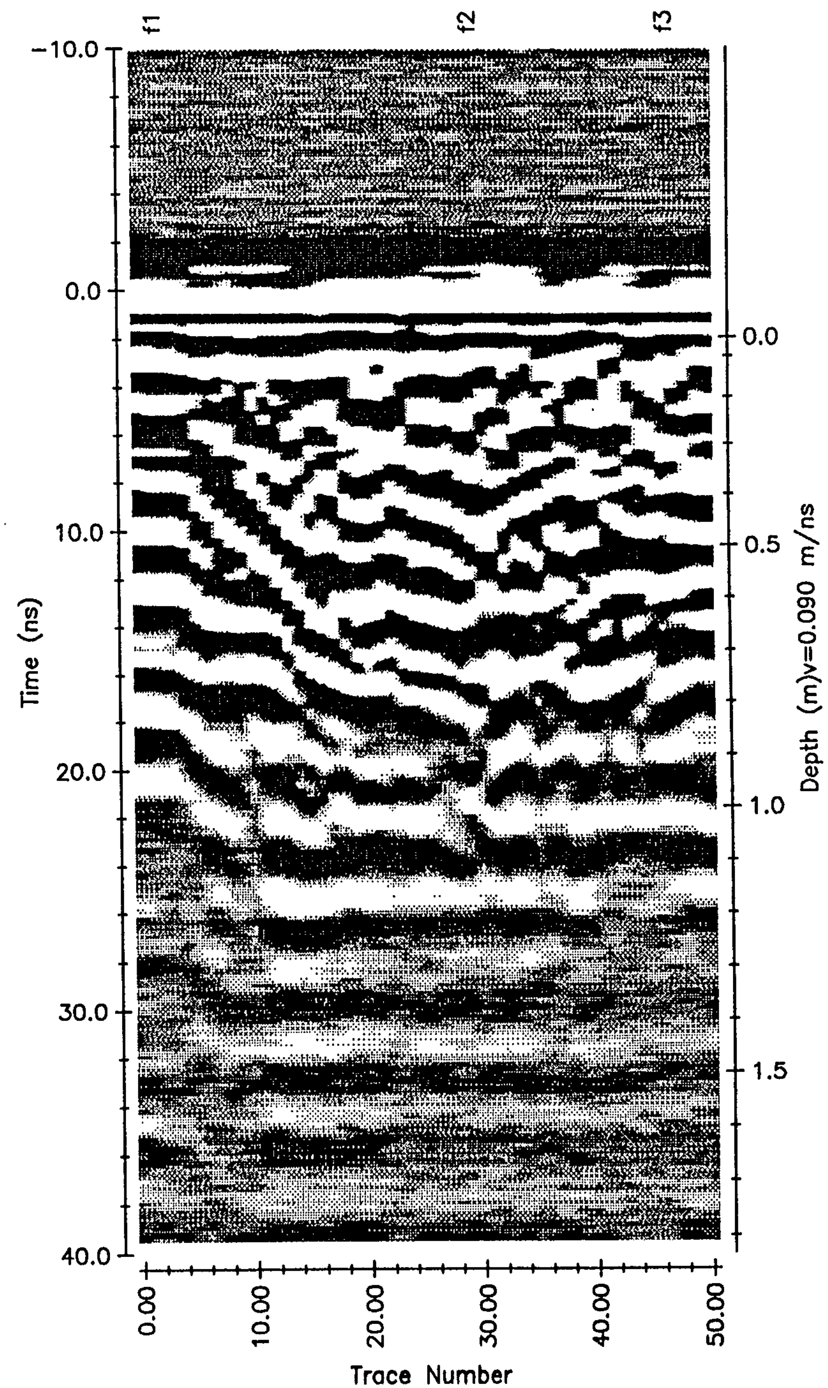
PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0750 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE    = s:\COASTG~1\21SEP0~1\CG450PS4
     JOB#    =
     TITLE   = Alabama Shipyard, Bulk Handling Area
     TITLE   = Powered Gypsum Pile, 450 MHz, Sugar - East Edge of Pile
     DATE    = 21/09/10
     NUMBER OF TRACES      = 51
     NUMBER OF PTS/TRC     = 500
     TIMEZERO AT POINT     = 105
     TOTAL TIME WINDOW     = 50
     STARTING POSITION     = 0.000
     FINAL POSITION        = 50.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 450.00
     ANTENNA SEPARATION    = 0.250
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 4
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                            TX: 981121 ANT: 971181/82

PROCESSING SELECTED
     FILTERS:    TRACE STACKING: 2
                 POINT STACKING: 2
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
     SELECTION   TIME: -10 to 40
                 POSITIONS: 0.000 to 50.000
     GAINS:      GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0750 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

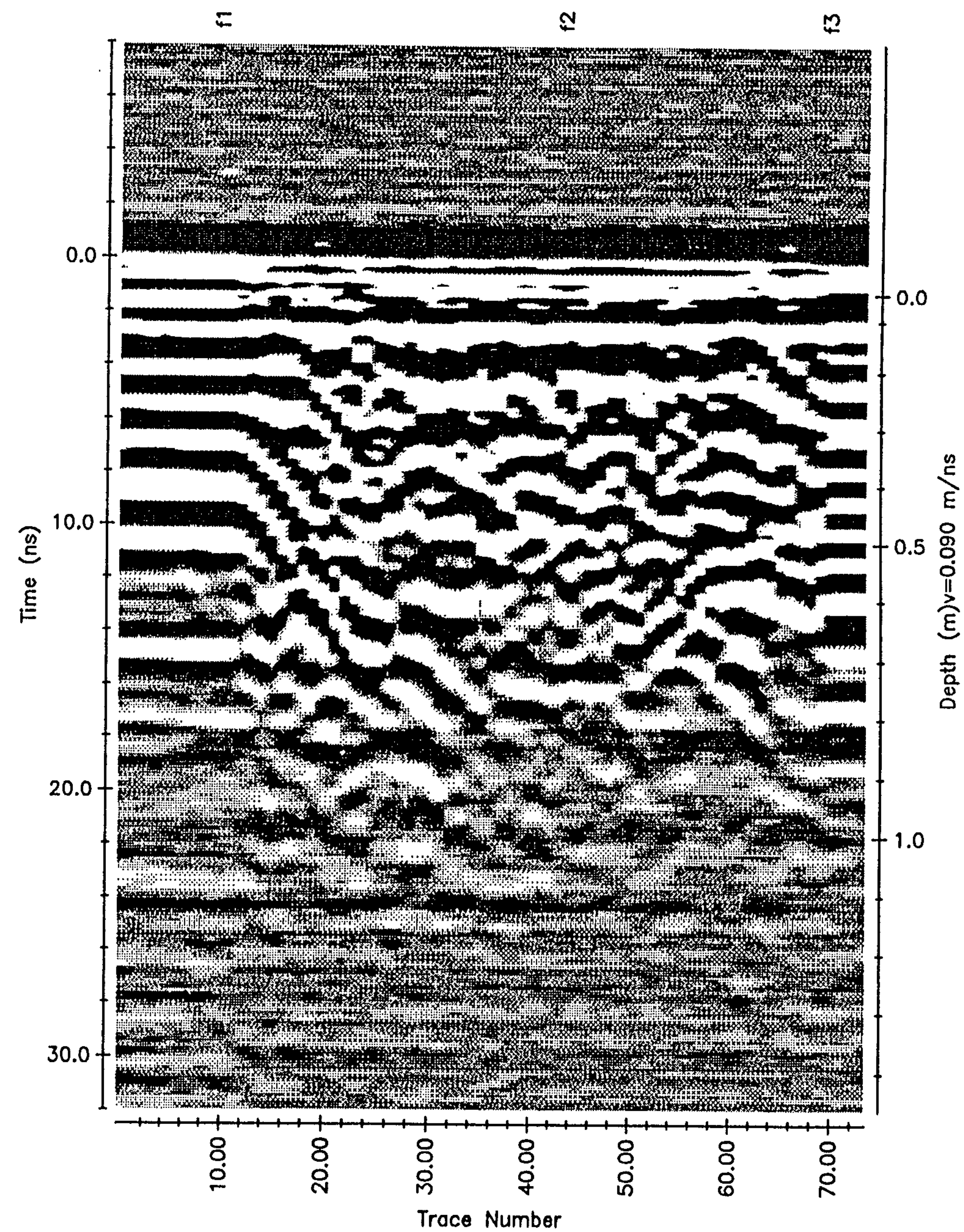
FILE = s:\COASTG~1\21SEP0~1\CG900PS1
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Powered Gypsum Pile, 900 MHz, Sugar – West Edge of Pile
DATE = 21/09/10
NUMBER OF TRACES = 74
NUMBER OF PTS/TRC = 400
TIMEZERO AT POINT = 80
TOTAL TIME WINDOW = 40
STARTING POSITION = 0.000
FINAL POSITION = 73.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 900.00
ANTENNA SEPARATION = 0.170
PULSER VOLTAGE = 200
NUMBER OF STACKS = 4
SURVEY MODE = Reflection
COLLECTED BY PE1000 – CON: 981119 RX: 981120
TX: 981121 ANT: 971258/59

PROCESSING SELECTED

FILTERS: TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: -8 to 32
POSITIONS: 0.000 to 73.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS

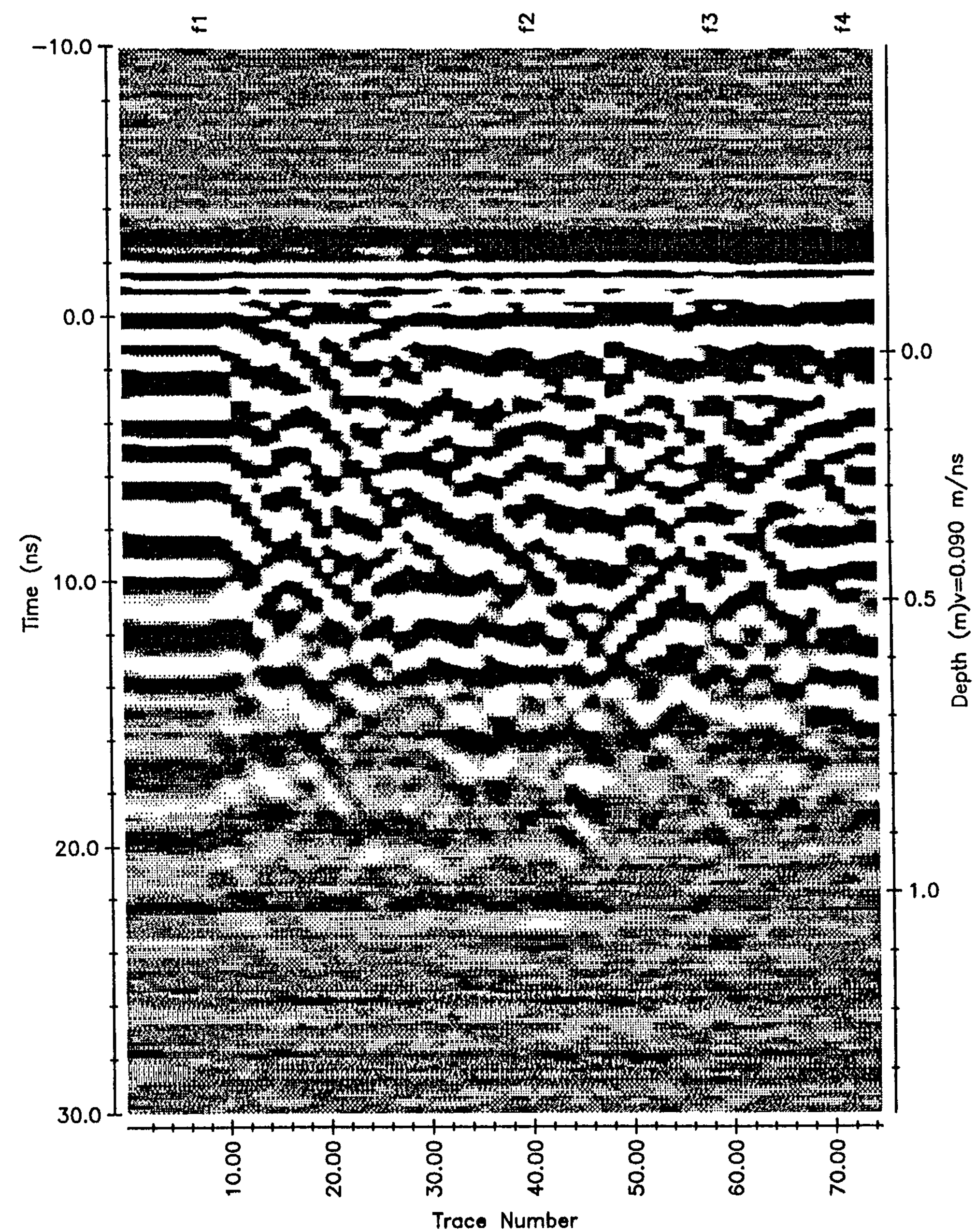
TRACE SPACING AND WIDTH: 0.0750 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\21SEP0~1\CG900PS2
     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Powered Gypsum Pile, 900 MHz, Sugar - Profile Over Sugar
     DATE   = 21/09/10
     NUMBER OF TRACES      = 75
     NUMBER OF PTS/TRC     = 400
     TIMEZERO AT POINT     = 100
     TOTAL TIME WINDOW     = 40
     STARTING POSITION     = 0.000
     FINAL POSITION        = 74.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 900.00
     ANTENNA SEPARATION    = 0.170
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 4
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971258/59

PROCESSING SELECTED
     FILTERS:      TRACE STACKING: 2
                   POINT STACKING: 2
                   TRACE DIFFERENCING: N
                   CORRECTION: DEWOW
     SELECTION     TIME: -10 to 30
                   POSITIONS: 0.000 to 74.000
     GAINS:        GAIN TYPE: CONSTANT
                   MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0750 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

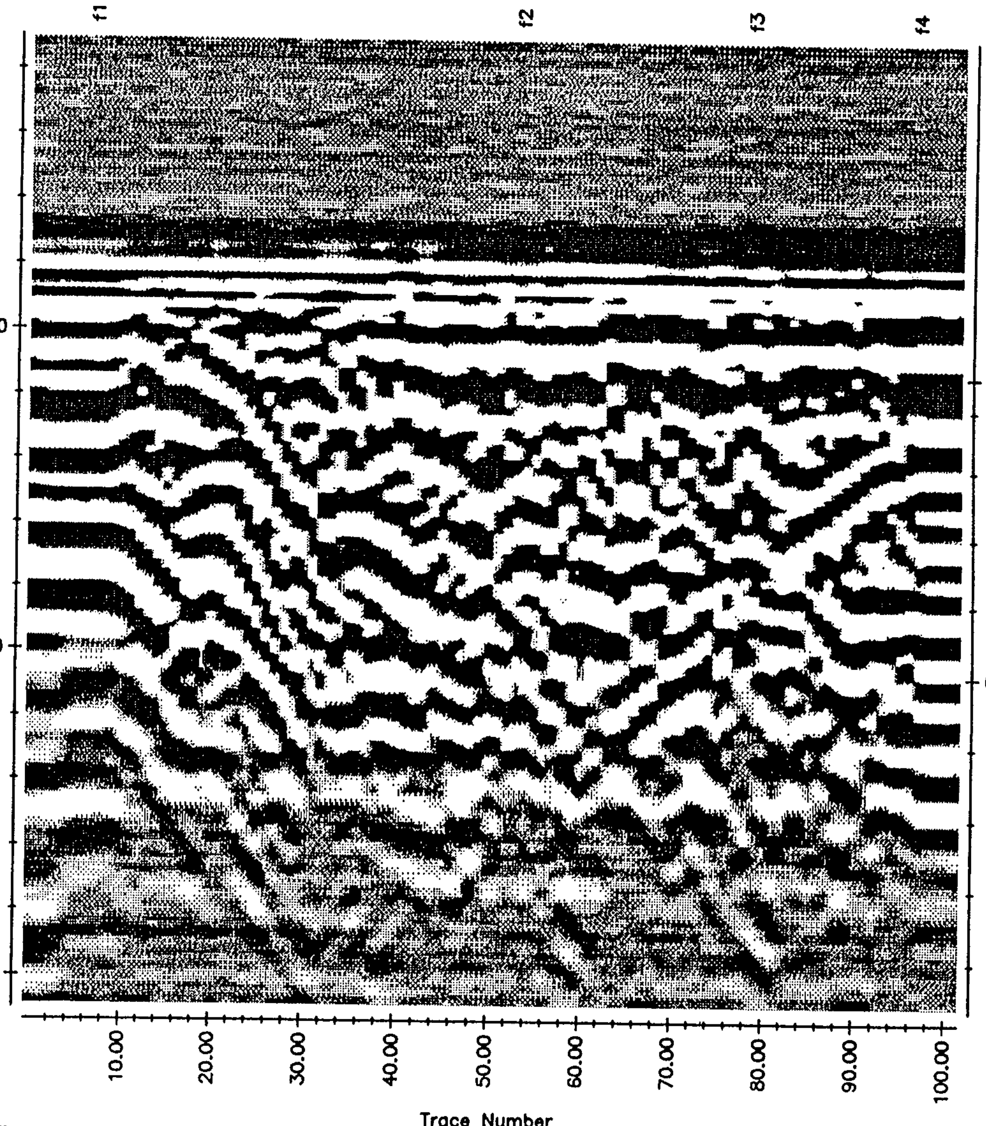
```
FILE = s:\COASTG~1\21SEP0~1\CG900PS3
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Powered Gypsum Pile, 900 MHz, Sugar - Profile Over Sugar
DATE = 21/09/10
NUMBER OF TRACES    = 102
NUMBER OF PTS/TRC   = 300
TIMEZERO AT POINT   = 91
TOTAL TIME WINDOW   = 30
STARTING POSITION   = 0.000
FINAL POSITION      = 101.000
STEP SIZE USED      = 1.000
POSITION UNITS      = metres
NOMINAL FREQUENCY   = 900.00
ANTENNA SEPARATION  = 0.170
PULSER VOLTAGE      = 200
NUMBER OF STACKS    = 4
SURVEY MODE         = Reflection
COLLECTED BY PE1000 - CON: 981119 RX: 981120
                      TX: 981121 ANT: 971258/59
```

PROCESSING SELECTED

```
FILTERS:    TRACE STACKING: 2
            POINT STACKING: 2
            TRACE DIFFERENCING: N
            CORRECTION: DEWOW
SELECTION   TIME: -9 to 21
            POSITIONS: 0.000 to 101.000
GAINS:      GAIN TYPE: CONSTANT
            MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

```
TRACE SPACING AND WIDTH: 0.0750 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

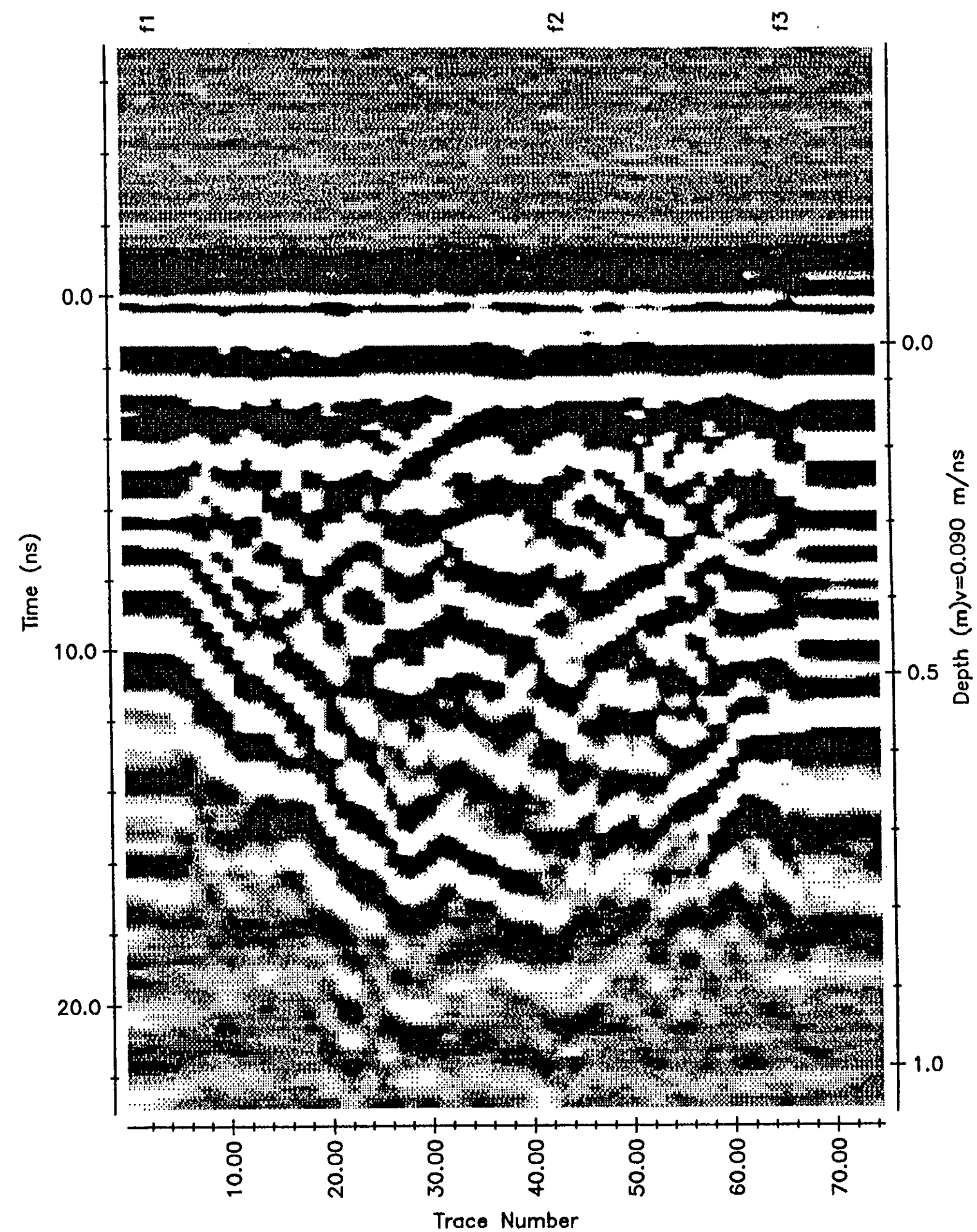
```
FILE  = s:\COASTG~1\21SEP0~1\CG900PS4
JOB#  =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Powered Gypsum Pile, 900 MHz, Sugar -- East Edge of Pile
DATE  = 21/09/10
NUMBER OF TRACES     = 75
NUMBER OF PTS/TRC    = 300
TIMEZERO AT POINT    = 71
TOTAL TIME WINDOW    = 30
STARTING POSITION    = 0.000
FINAL POSITION       = 74.000
STEP SIZE USED       = 1.000
POSITION UNITS       = metres
NOMINAL FREQUENCY    = 900.00
ANTENNA SEPARATION   = 0.170
PULSER VOLTAGE       = 200
NUMBER OF STACKS     = 4
SURVEY MODE          = Reflection
COLLECTED BY PE1000 - CON: 981119 RX: 981120
                      TX: 981121 ANT: 971258/59
```

PROCESSING SELECTED

```
FILTERS:     TRACE STACKING: 2
             POINT STACKING: 2
             TRACE DIFFERENCING: N
             CORRECTION: DEWOW
SELECTION    TIME: -7 to 23
             POSITIONS: 0.000 to 74.000
GAINS:       GAIN TYPE: CONSTANT
             MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

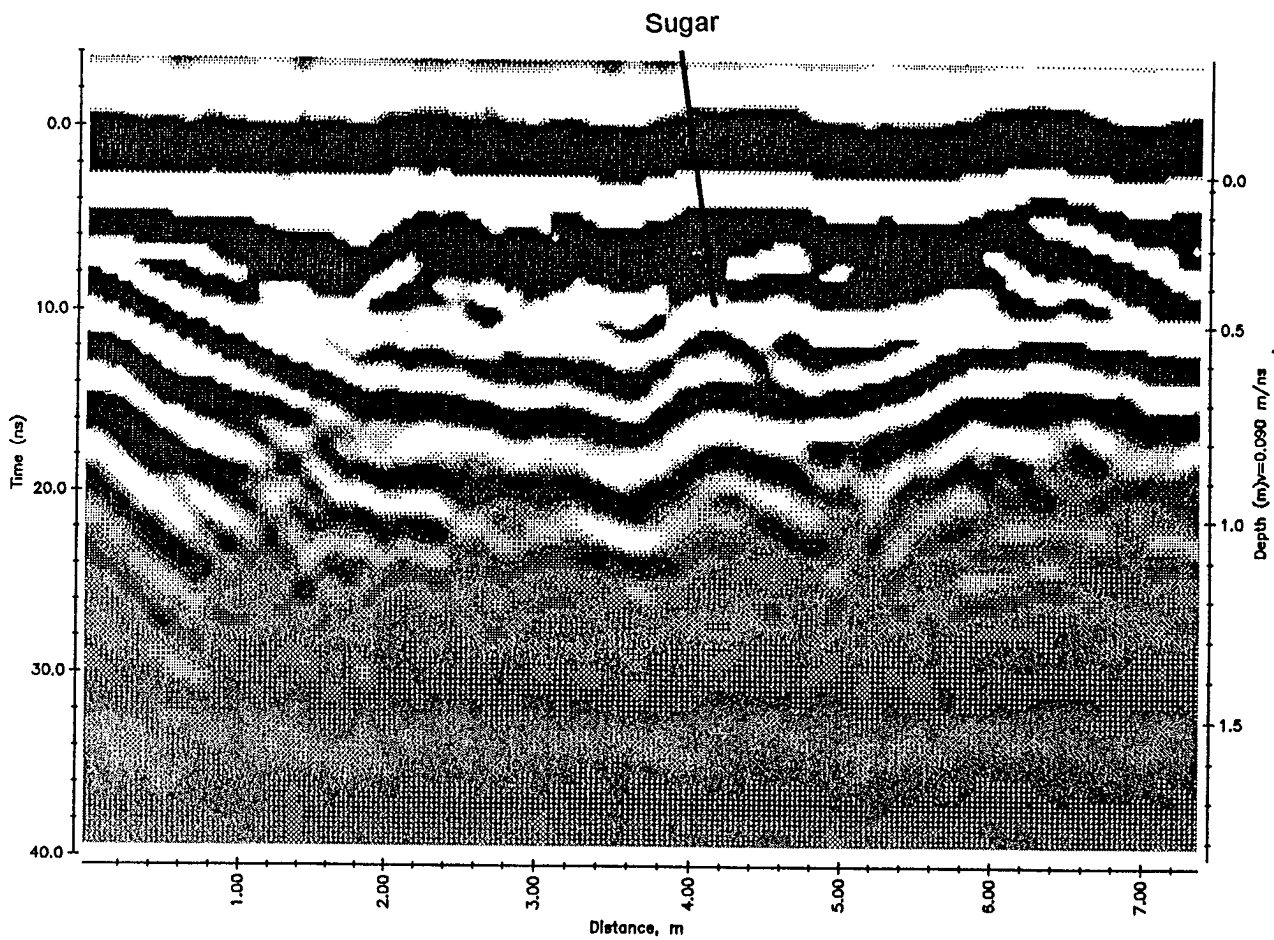
```
TRACE SPACING AND WIDTH: 0.0750 and 0.2500
TRACE BOTTOM AND TOP: 1.0000  and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
    FILE  = s:\COASTG~1\21SEP0~1\CG250PS0
    JOB#  =
    TITLE = Alabama Shipyard, Bulk Handling Area
    TITLE = Powdered Gypsum Pile, 250 MHz, Sugar - West Edge of Pile
    DATE  = 09/21/20
    NUMBER OF TRACES      = 148
    NUMBER OF PTS/TRC     = 111
    TIMEZERO AT POINT     = 11
    TOTAL TIME WINDOW     = 44
    STARTING POSITION     = 0.000
    FINAL POSITION        = 7.350
    STEP SIZE USED        = 0.050
    POSITION UNITS        = m
    NOMINAL FREQUENCY     = 250.00
    ANTENNA SEPARATION    = 0.305
    PULSER VOLTAGE        = 100
    NUMBER OF STACKS      = 16
    SURVEY MODE           = Reflection

PROCESSING SELECTED
    FILTERS:    TRACE STACKING: 2
                POINT STACKING: 2
                TRACE DIFFERENCING: N
                CORRECTION: DEWOW
    SELECTION   TIME: -4 to 40
                POSITIONS: 0.000 to 7.350
    GAINS:      GAIN TYPE: CONSTANT
                MULTIPLIER: 100.000

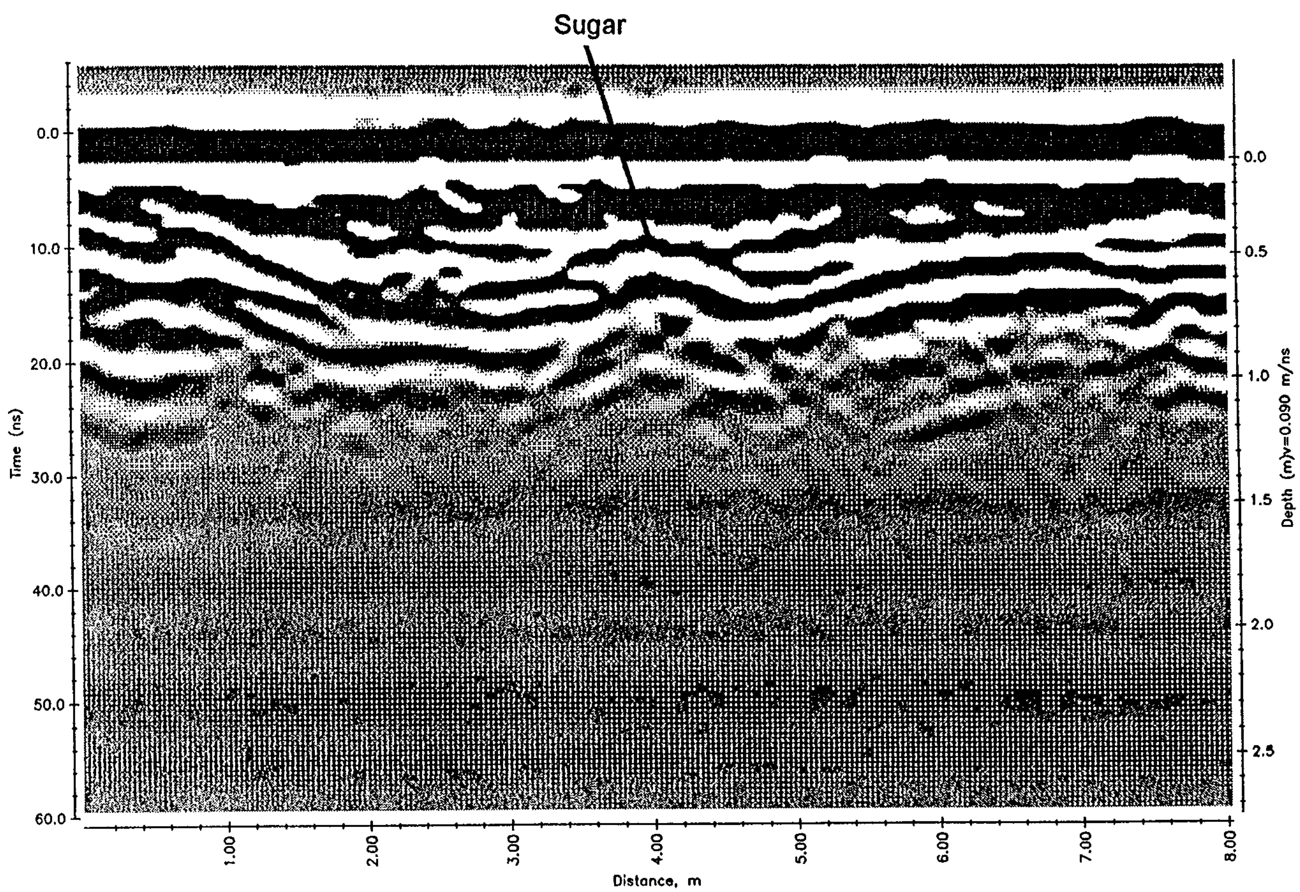
PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.0750 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000 and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS
FILE = s:\COASTG~1\21SEP0~1\CG250PS1
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Powdered Gypsum Pile, 250 MHz, Sugar - Profile Over Sugar
DATE = 09/21/20
NUMBER OF TRACES = 161
NUMBER OF PTS/TRC = 166
TIMEZERO AT POINT = 16
TOTAL TIME WINDOW = 66
STARTING POSITION = 0.000
FINAL POSITION = 8.000
STEP SIZE USED = 0.050
POSITION UNITS = m
NOMINAL FREQUENCY = 250.00
ANTENNA SEPARATION = 0.305
PULSER VOLTAGE = 100
NUMBER OF STACKS = 16
SURVEY MODE = Reflection

PROCESSING SELECTED
FILTERS: TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: -6 to 60
POSITIONS: 0.000 to 8.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

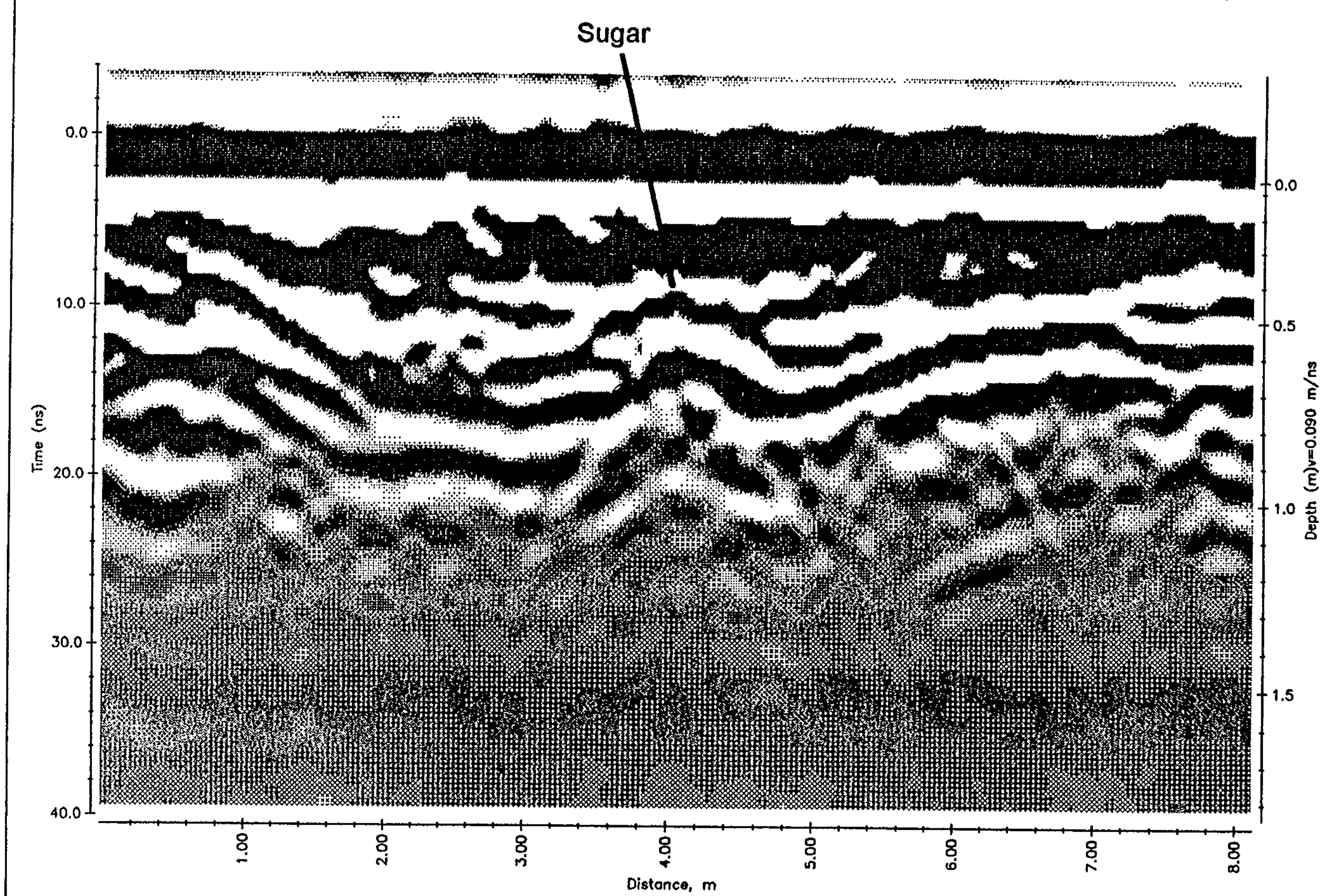
PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0750 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



```
pulseEKKO HEADER PARAMETERS
    FILE   = s:\COASTG~1\21SEP0~1\CG250PS2
    JOB#   =
    TITLE  =  Alabama Shipyard, Bulk Handling Area
    TITLE  = Powdered Gypsum Pile, 250 MHz, Sugar - Profile Over Sugar
    DATE   = 09/21/20
    NUMBER OF TRACES      = 163
    NUMBER OF PTS/TRC     = 111
    TIMEZERO AT POINT     = 11
    TOTAL TIME WINDOW     = 44
    STARTING POSITION     = 0.000
    FINAL POSITION        = 8.100
    STEP SIZE USED        = 0.050
    POSITION UNITS        = m
    NOMINAL FREQUENCY     = 250.00
    ANTENNA SEPARATION    = 0.305
    PULSER VOLTAGE        = 100
    NUMBER OF STACKS      = 16
    SURVEY MODE           = Reflection
    ction

PROCESSING SELECTED
    FILTERS:     TRACE STACKING: 2
                 POINT STACKING: 2
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
    SELECTION    TIME: -4 to 40
                 POSITIONS: 0.000 to 8.100
    GAINS:       GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000

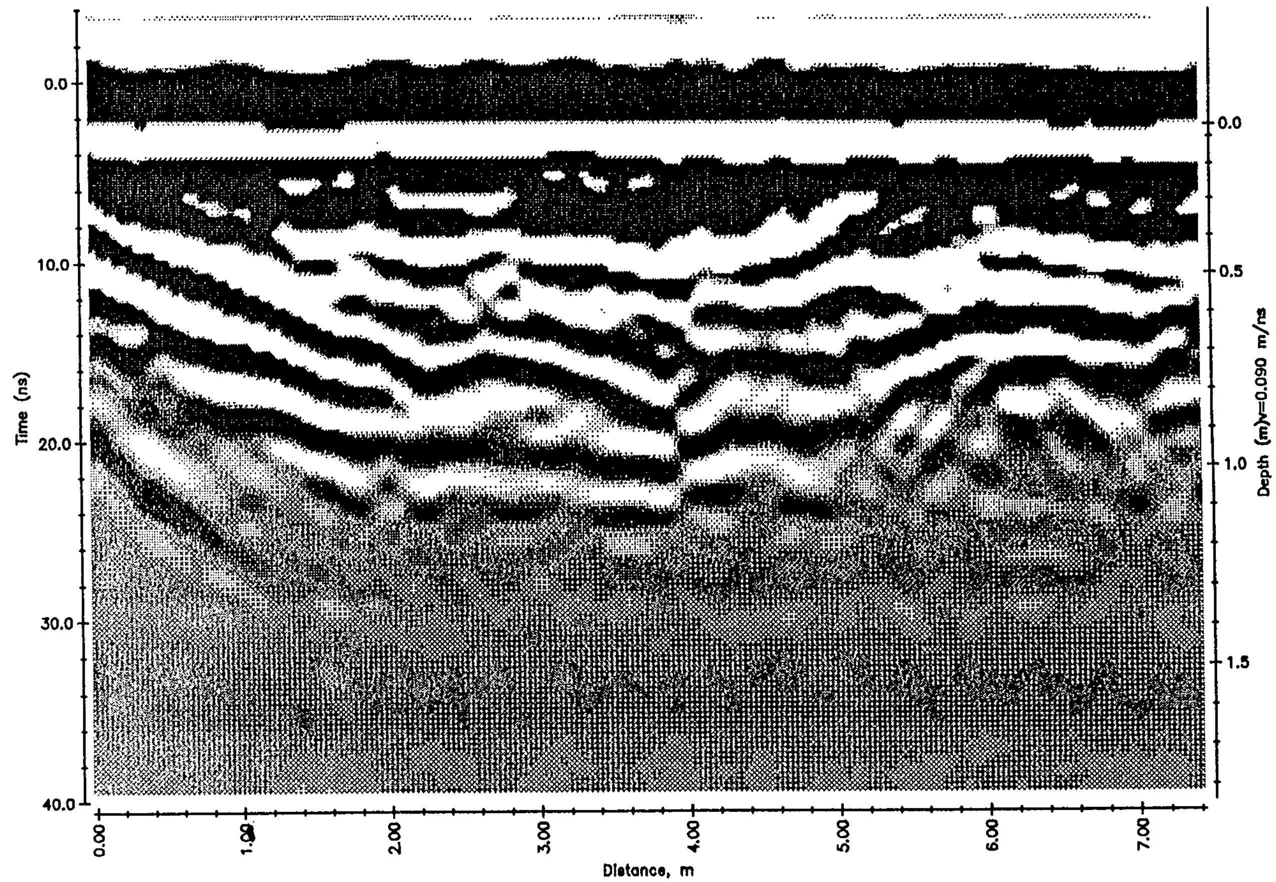

PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.0750 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
    FILE   = s:\COASTG~1\21SEP0~1\CG250PS3
    JOB#   =
    TITLE  = Alabama Shipyard, Bulk Handling Area
    TITLE  = Powdered Gypsum Pile, 250 MHz, Sugar - East Edge of Pile
    DATE   = 09/21/20
    NUMBER OF TRACES      = 149
    NUMBER OF PTS/TRC     = 111
    TIMEZERO AT POINT     = 11
    TOTAL TIME WINDOW     = 44
    STARTING POSITION     = 0.000
    FINAL POSITION        = 7.400
    STEP SIZE USED        = 0.050
    POSITION UNITS        = m
    NOMINAL FREQUENCY     = 250.00
    ANTENNA SEPARATION    = 0.305
    PULSER VOLTAGE        = 100
    NUMBER OF STACKS      = 16
    SURVEY MODE           = Reflection

PROCESSING SELECTED
    FILTERS:     TRACE STACKING: 2
                 POINT STACKING: 2
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
    SELECTION    TIME: -4 to 40
                 POSITIONS: 0.000 to 7.400
    GAINS:       GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000

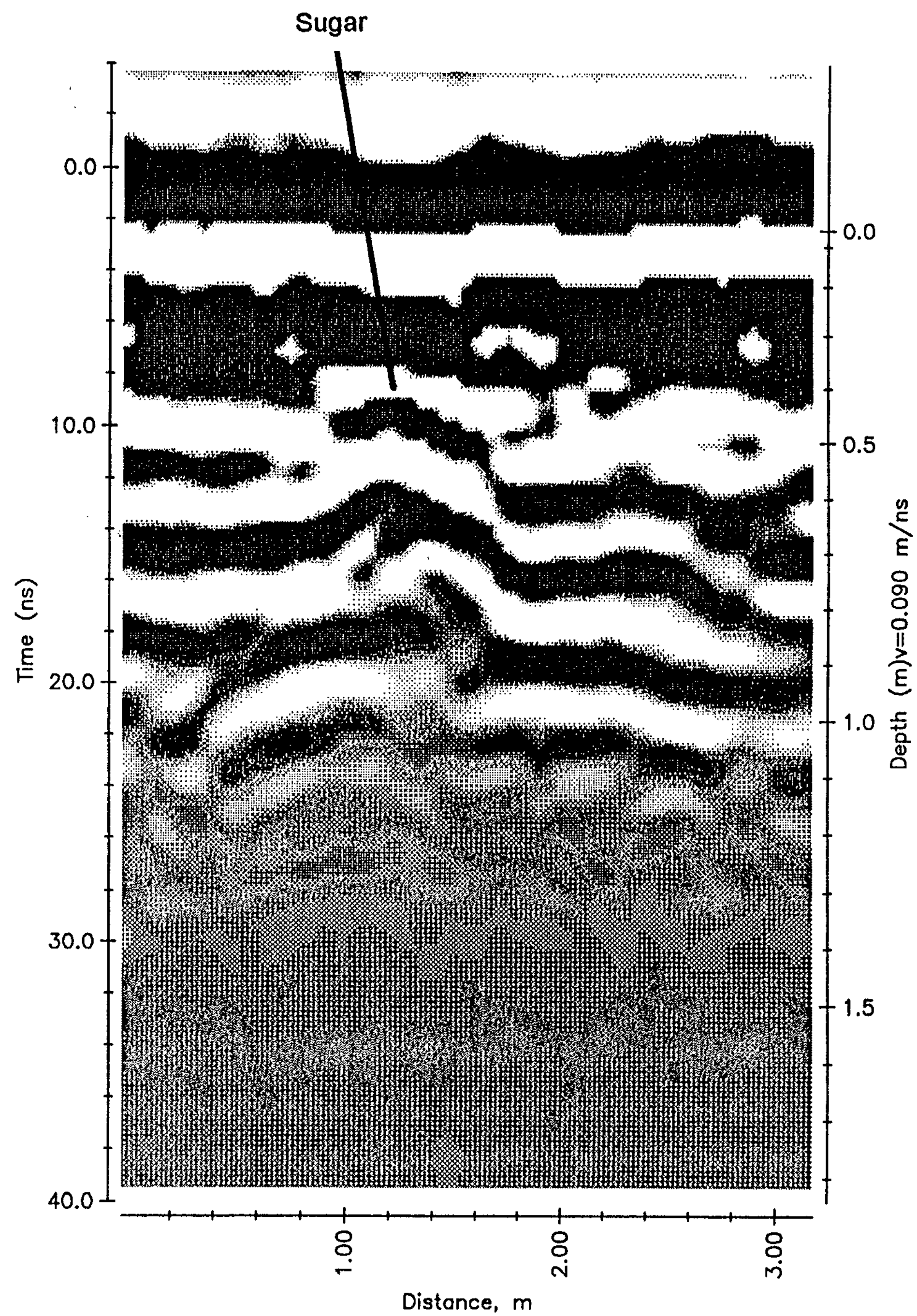
PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.0750 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\21SEP0~1\CG250PS4
     JOB#  =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Powdered Gypsum Pile, 250 MHz, Sugar -E/W Profile Over Sugar
     DATE   = 09/21/20
     NUMBER OF TRACES     = 64
     NUMBER OF PTS/TRC    = 111
     TIMEZERO AT POINT    = 11
     TOTAL TIME WINDOW    = 44
     STARTING POSITION    = 0.000
     FINAL POSITION       = 3.150
     STEP SIZE USED       = 0.050
     POSITION UNITS       = m
     NOMINAL FREQUENCY    = 250.00
     ANTENNA SEPARATION   = 0.305
     PULSER VOLTAGE       = 100
     NUMBER OF STACKS     = 16
     SURVEY MODE          = Reflection

PROCESSING SELECTED
     FILTERS:      TRACE STACKING: 2
                   POINT STACKING: 2
                   TRACE DIFFERENCING: N
                   CORRECTION: DEWOW
     SELECTION     TIME: -4 to 40
                   POSITIONS: 0.000 to 3.150
     GAINS:        GAIN TYPE: CONSTANT
                   MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0750 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```

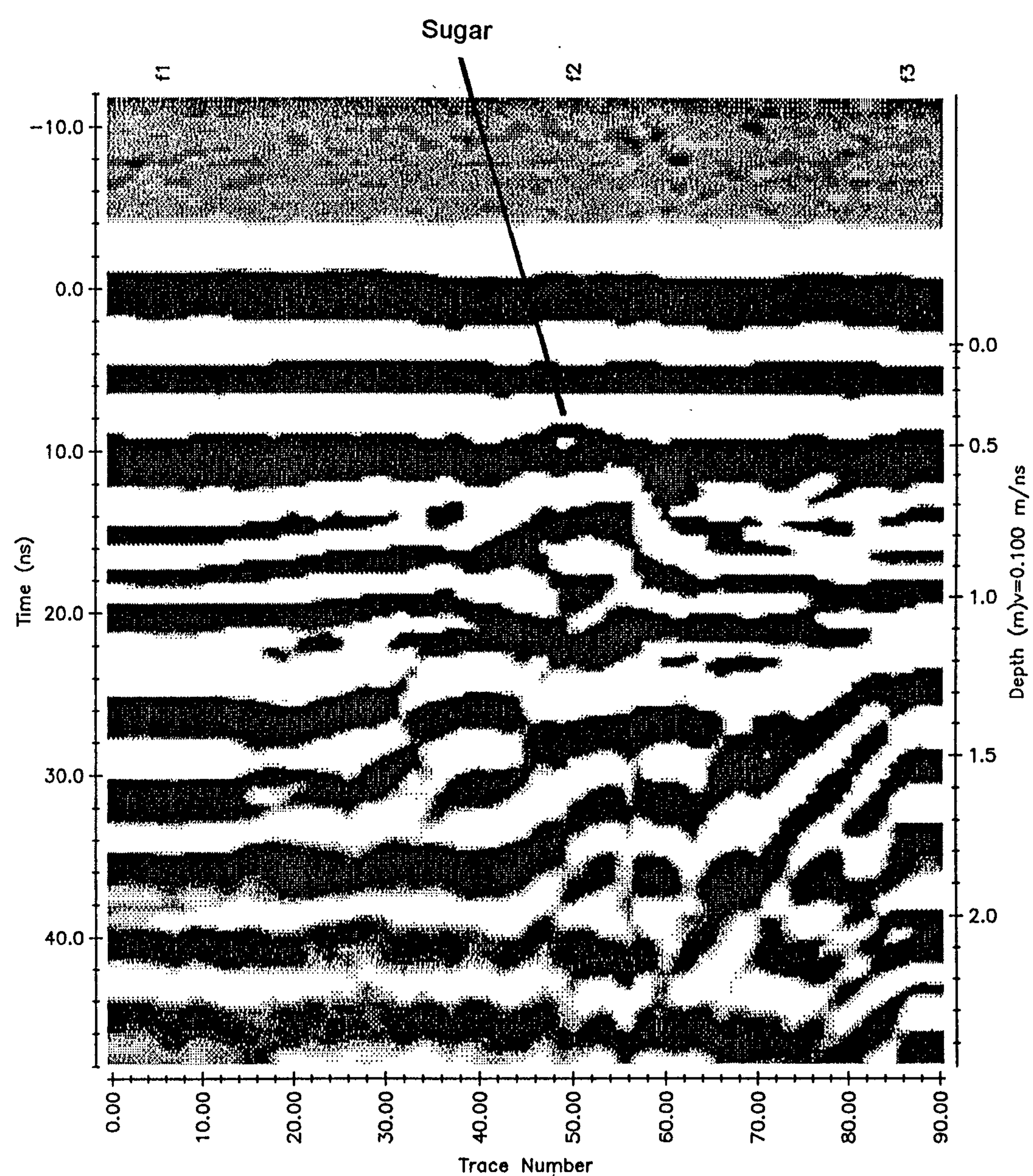


Appendix G
Crushed Pumice
GPR Records – Buried Contraband Simulant Test

```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\21SEP0~1\CG225MS1
     JOB#  =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Pumice Pile, 225 MHz, Sugar - Profile Over Sugar
     DATE  = 21/09/10
     NUMBER OF TRACES      = 91
     NUMBER OF PTS/TRC     = 200
     TIMEZERO AT POINT     = 40
     TOTAL TIME WINDOW     = 60
     STARTING POSITION     = 0.000
     FINAL POSITION        = 90.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 225.00
     ANTENNA SEPARATION    = 0.500
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 4
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971195/96

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 2
                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -12 to 48
                  POSITIONS: 0.000 to 90.000
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000

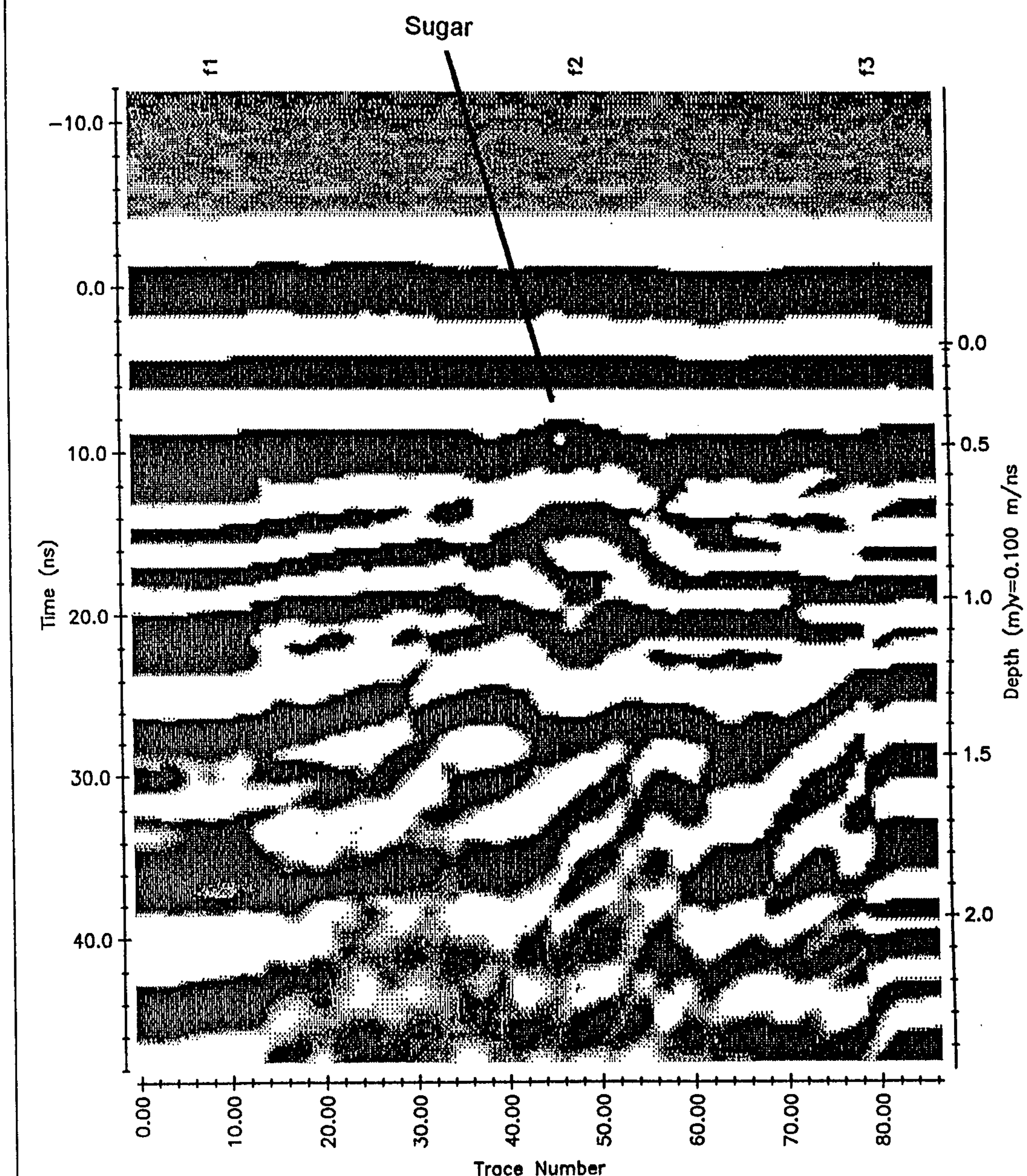
PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0750 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\21SEP0~1\CG225MS2
     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Pumice Pile, 225 MHz, Sugar - Profile Over Sugar
     DATE   = 21/09/10
     NUMBER OF TRACES      = 87
     NUMBER OF PTS/TRC     = 200
     TIMEZERO AT POINT     = 41
     TOTAL TIME WINDOW     = 60
     STARTING POSITION     = 0.000
     FINAL POSITION        = 86.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 225.00
     ANTENNA SEPARATION    = 0.500
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 4
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971195/96

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 2
                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -12 to 48
                  POSITIONS: 0.000 to 86.000
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0750 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

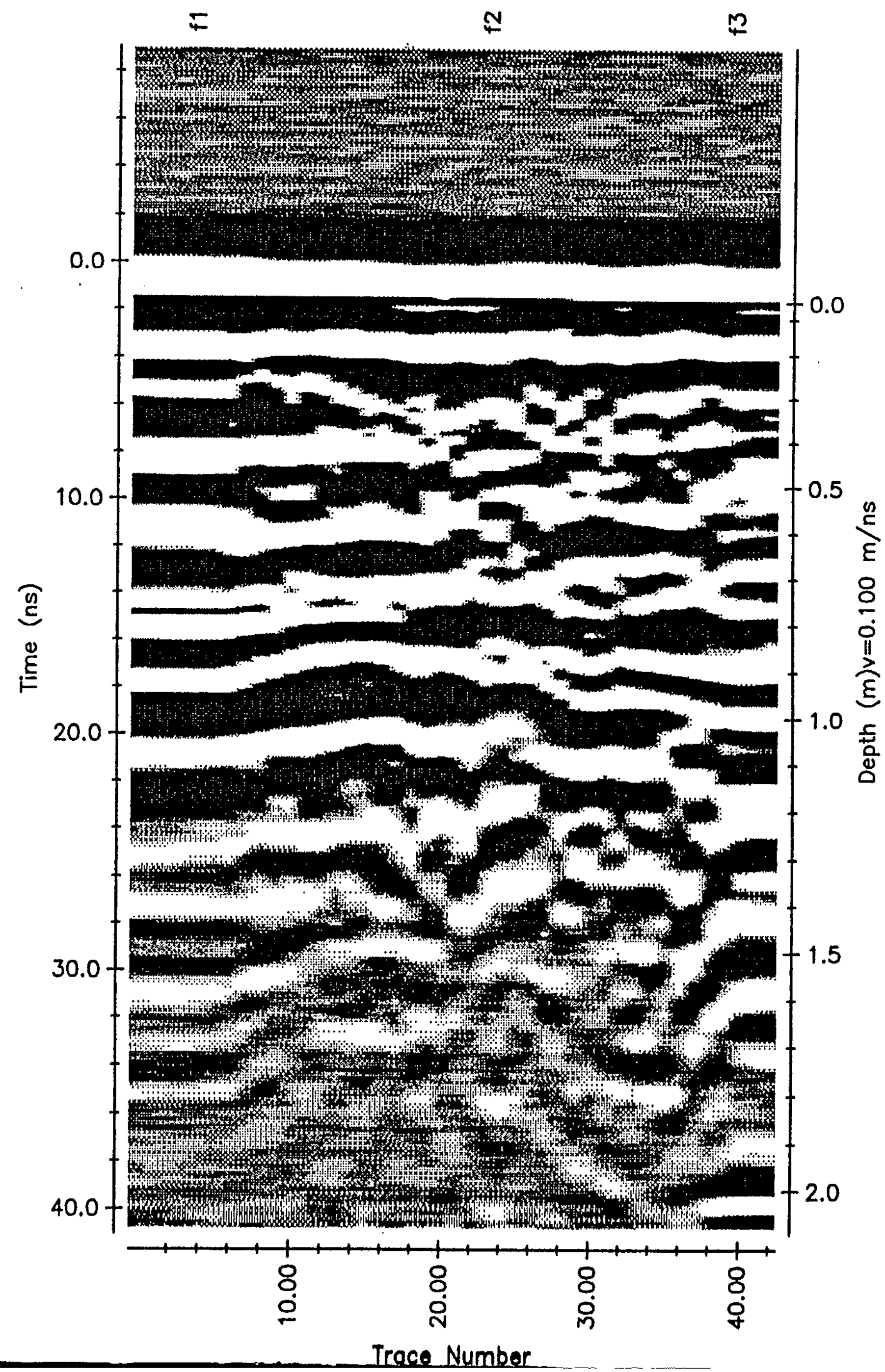
```
     FILE  = s:\COASTG~1\21SEP0~1\CG450MS1
     JOB#  =
     TITLE = Alabama Shipyard, Bulk Handling Area
     TITLE = Pumice Pile, 450 MHz, Sugar - Profile Over Sugar
     DATE  = 21/09/10
     NUMBER OF TRACES      = 43
     NUMBER OF PTS/TRC     = 500
     TIMEZERO AT POINT     = 92
     TOTAL TIME WINDOW     = 50
     STARTING POSITION     = 0.000
     FINAL POSITION        = 42.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 450.00
     ANTENNA SEPARATION    = 0.250
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 4
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971181/82
```

PROCESSING SELECTED

```
     FILTERS:    TRACE STACKING: 2
                 POINT STACKING: 2
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
     SELECTION   TIME: -9 to 41
                 POSITIONS: 0.000 to 42.000
     GAINS:      GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

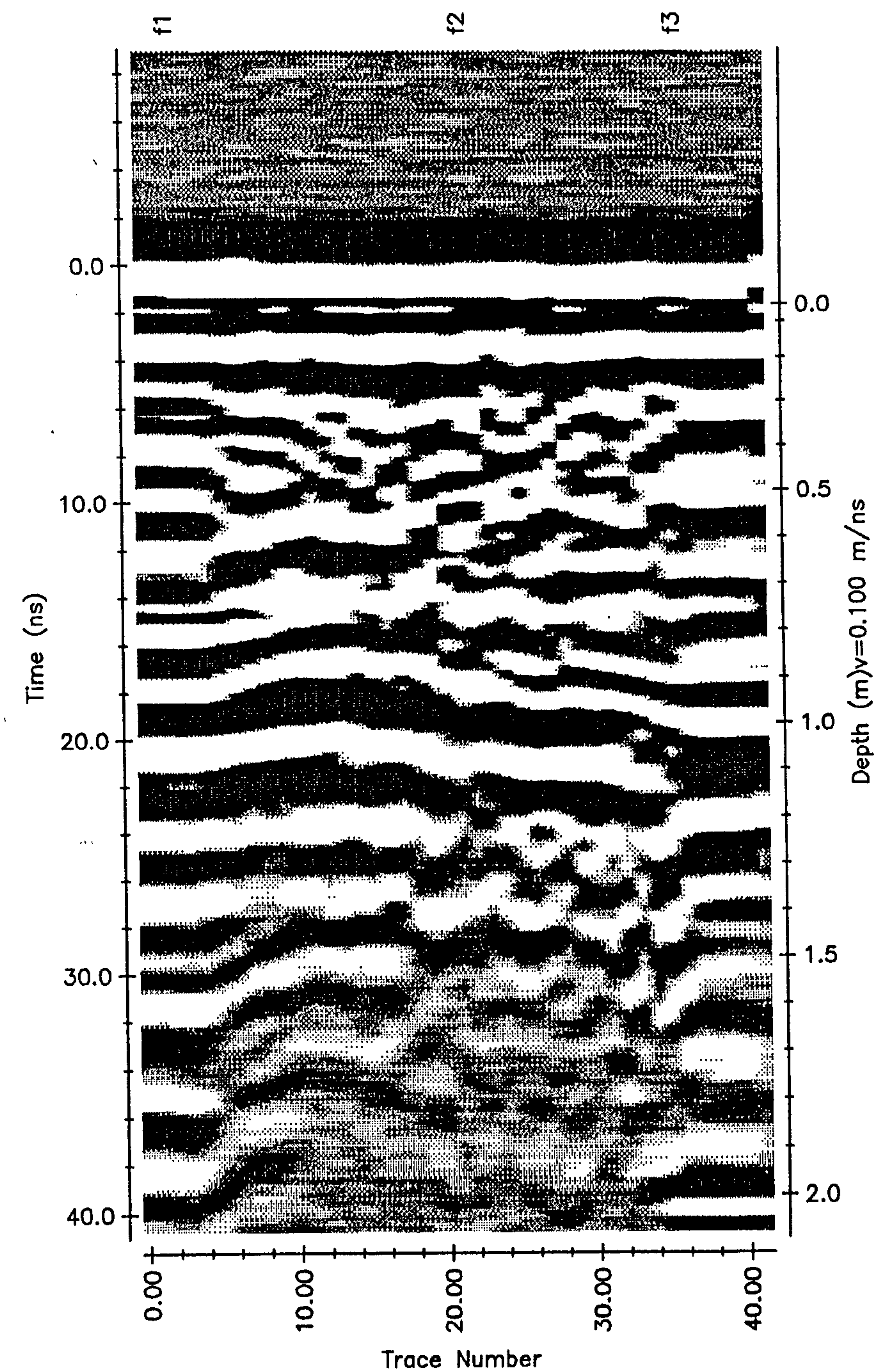
```
     TRACE SPACING AND WIDTH: 0.1000 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE  = s:\COASTG~1\21SEP0~1\CG450MS2
     JOB#  =
     TITLE = Alabama Shipyard, Bulk Handling Area
     TITLE = Pumice Pile, 450 MHz, Sugar - Profile Over Sugar
     DATE  = 21/09/10
     NUMBER OF TRACES     = 42
     NUMBER OF PTS/TRC    = 500
     TIMEZERO AT POINT    = 92
     TOTAL TIME WINDOW    = 50
     STARTING POSITION    = 0.000
     FINAL POSITION       = 41.000
     STEP SIZE USED       = 1.000
     POSITION UNITS       = metres
     NOMINAL FREQUENCY    = 450.00
     ANTENNA SEPARATION   = 0.250
     PULSER VOLTAGE       = 200
     NUMBER OF STACKS     = 4
     SURVEY MODE          = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971181/82

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 2
                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -9 to 41
                  POSITIONS: 0.000 to 41.000
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000

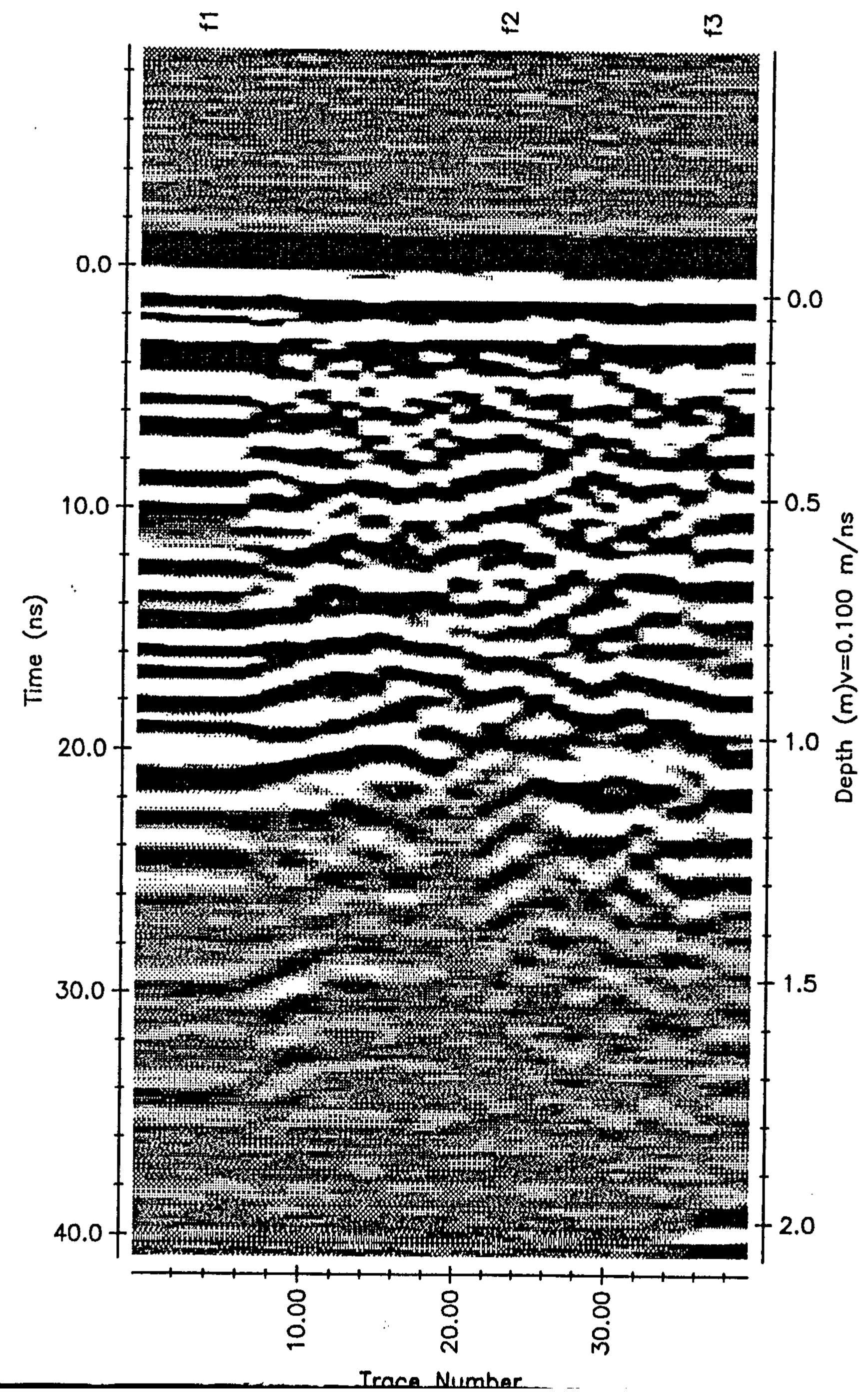
PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.1000 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE  = s:\COASTG~1\21SEP0~1\CG900MS1
     JOB#  =
     TITLE = Alabama Shipyard, Bulk Handling Area
     TITLE = Pumice Pile, 900 MHz, Sugar - Profile Over Sugar
     DATE  = 21/09/10
     NUMBER OF TRACES      = 40
     NUMBER OF PTS/TRC     = 500
     TIMEZERO AT POINT     = 91
     TOTAL TIME WINDOW     = 50
     STARTING POSITION     = 0.000
     FINAL POSITION        = 39.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 900.00
     ANTENNA SEPARATION    = 0.170
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 4
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 -  CON: 981119 RX: 981120
                            TX: 981121 ANT: 971258/59

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 2
                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -9 to 41
                  POSITIONS: 0.000 to 39.000
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000

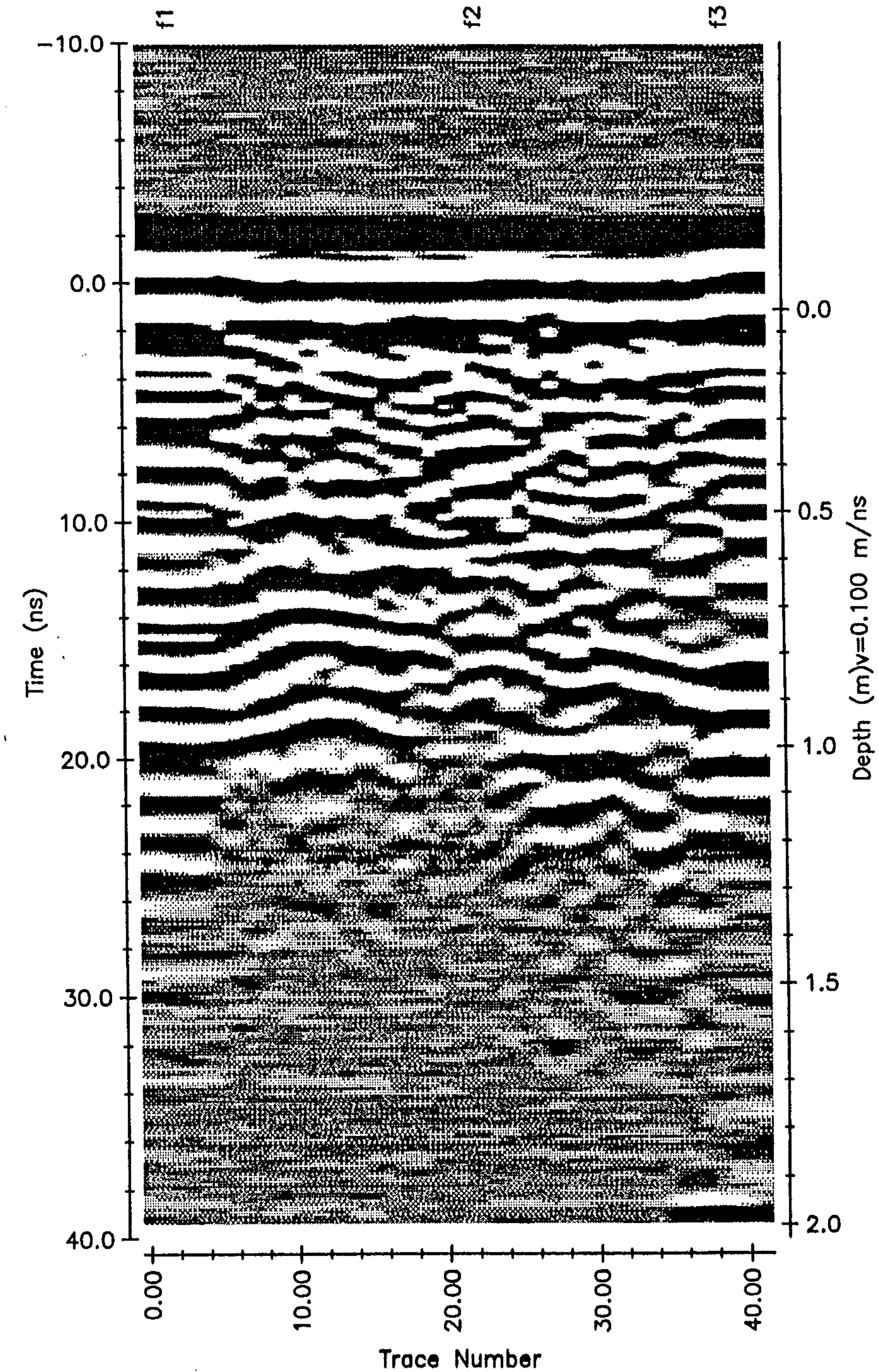

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.1000 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\21SEP0~1\CG900MS2
     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Pumice Pile, 900 MHz, Sugar - Profile Over Sugar
     DATE   = 21/09/10
     NUMBER OF TRACES      = 42
     NUMBER OF PTS/TRC     = 500
     TIMEZERO AT POINT     = 106
     TOTAL TIME WINDOW     = 50
     STARTING POSITION     = 0.000
     FINAL POSITION        = 41.000
     STEP SIZE USED        = 1.000
     POSITION UNITS        = metres
     NOMINAL FREQUENCY     = 900.00
     ANTENNA SEPARATION    = 0.170
     PULSER VOLTAGE        = 200
     NUMBER OF STACKS      = 4
     SURVEY MODE           = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971258/59

PROCESSING SELECTED
     FILTERS:    TRACE STACKING: 2
                 POINT STACKING: 2
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
     SELECTION   TIME: -10 to 40
                 POSITIONS: 0.000 to 41.000
     GAINS:      GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000

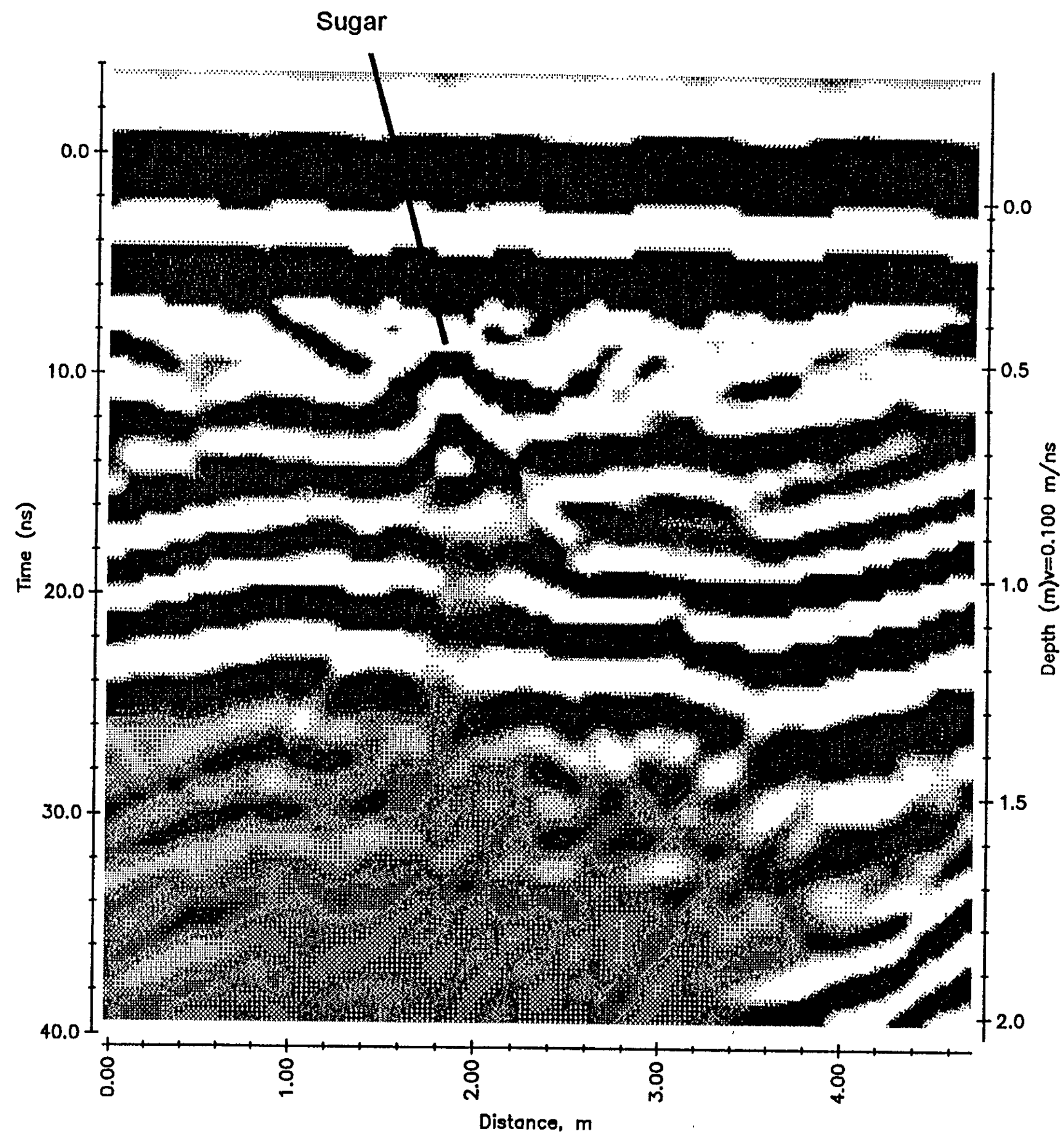
PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.1000 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
    FILE   = s:\COASTG~1\21SEP0~1\CG250MS0
    JOB#   =
    TITLE  = Alabama Shipyard, Bulk Handling Area
    TITLE  = Pumice Pile, 250 MHz, Sugar -- Profile Over Sugar
    DATE   = 09/21/20
    NUMBER OF TRACES       = 95
    NUMBER OF PTS/TRC      = 111
    TIMEZERO AT POINT      = 11
    TOTAL TIME WINDOW      = 44
    STARTING POSITION      = 0.000
    FINAL POSITION         = 4.700
    STEP SIZE USED         = 0.050
    POSITION UNITS         = m
    NOMINAL FREQUENCY      = 250.00
    ANTENNA SEPARATION     = 0.305
    PULSER VOLTAGE         = 100
    NUMBER OF STACKS       = 16
    SURVEY MODE            = Reflection

PROCESSING SELECTED
    FILTERS:    TRACE STACKING: 2
                POINT STACKING: 2
                TRACE DIFFERENCING: N
                CORRECTION: DEWOW
    SELECTION   TIME: -4 to 40
                POSITIONS: 0.000 to 4.700
    GAINS:      GAIN TYPE: CONSTANT
                MULTIPLIER: 100.000

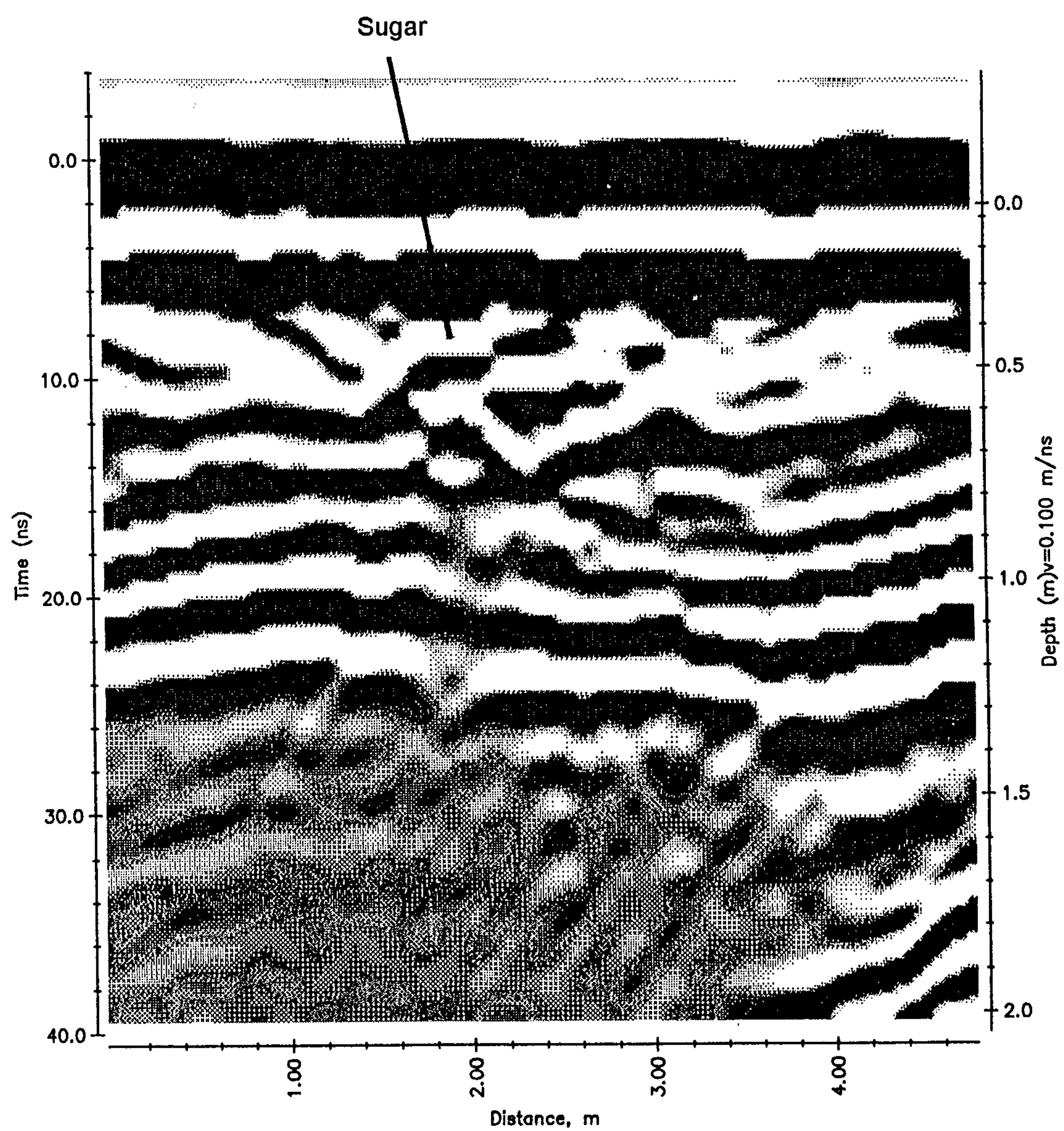
PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.0750 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\21SEP0~1\CG250MS1
     JOB#   =
     TITLE  = Alabama Shipyard, Bulk Handling Area
     TITLE  = Pumice Pile, 250 MHz, Sugar - Profile Over Sugar
     DATE   = 09/21/20
     NUMBER OF TRACES    = 96
     NUMBER OF PTS/TRC   = 111
     TIMEZERO AT POINT   = 11
     TOTAL TIME WINDOW   = 44
     STARTING POSITION   = 0.000
     FINAL POSITION      = 4.750
     STEP SIZE USED      = 0.050
     POSITION UNITS      = m
     NOMINAL FREQUENCY   = 250.00
     ANTENNA SEPARATION  = 0.305
     PULSER VOLTAGE      = 100
     NUMBER OF STACKS    = 16
     SURVEY MODE         = Reflection

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 2
                  POINT STACKING: 2
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -4 to 40
                  POSITIONS: 0.000 to 4.750
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0750 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```

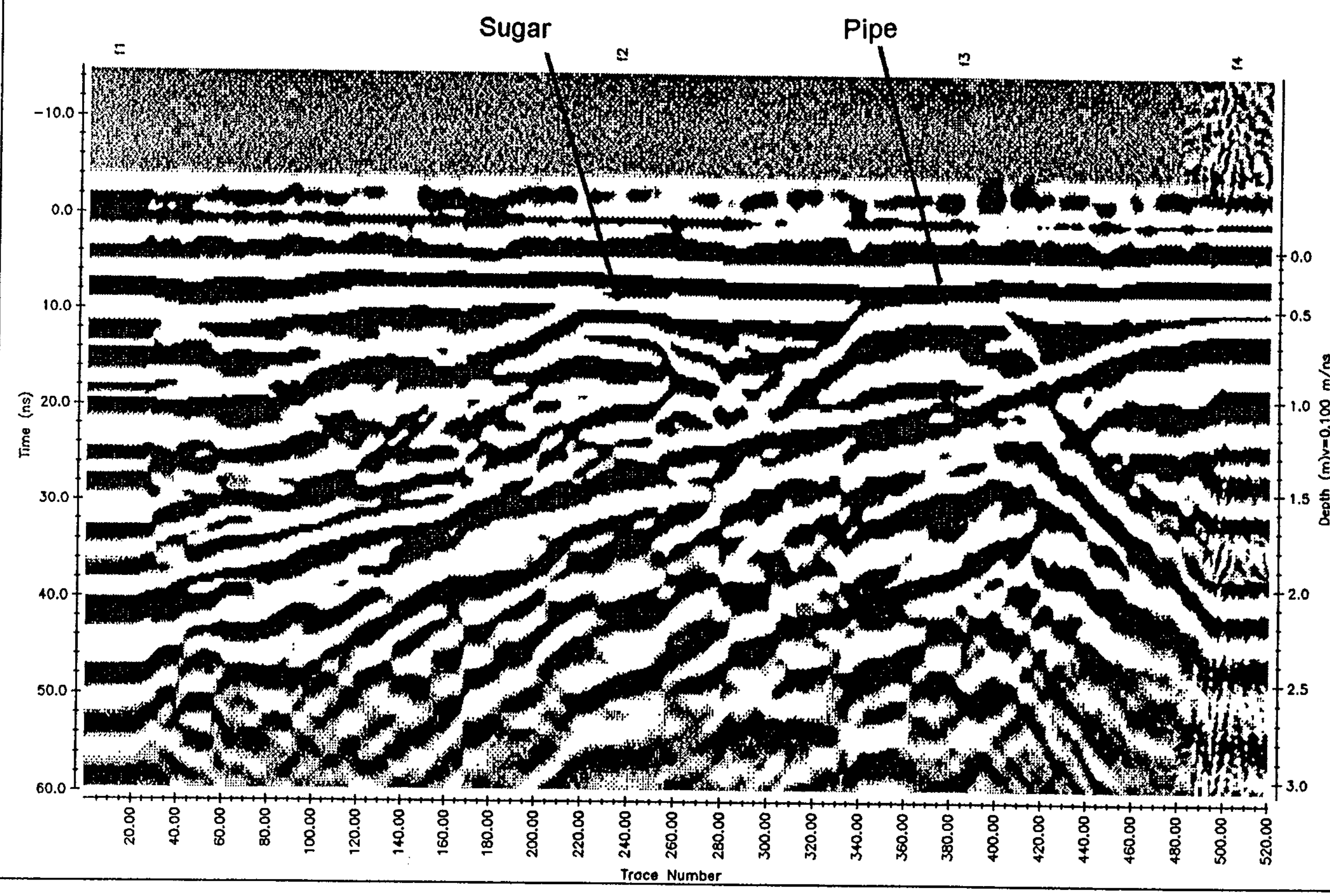


Appendix H
Bauxite
GPR Records – Buried Contraband Simulant Test

pulseEKKO HEADER PARAMETERS
FILE = s:\COASTG~1\21SEP0~1\CG225BS1
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Bauxite Pile, 225 MHz, Sugar – Profile Over Sugar and Pipe
DATE = 21/09/10
NUMBER OF TRACES = 521
NUMBER OF PTS/TRC = 250
TIMEZERO AT POINT = 51
TOTAL TIME WINDOW = 75
STARTING POSITION = 0.000
FINAL POSITION = 520.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 225.00
ANTENNA SEPARATION = 0.500
PULSER VOLTAGE = 200
NUMBER OF STACKS = 4
SURVEY MODE = Reflection
COLLECTED BY PE1000 – CON: 981119 RX: 981120
TX: 981121 ANT: 971195/96

PROCESSING SELECTED
FILTERS: TRACE STACKING: 2
POINT STACKING: 2
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: -15 to 60
POSITIONS: 0.000 to 520.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0250 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS

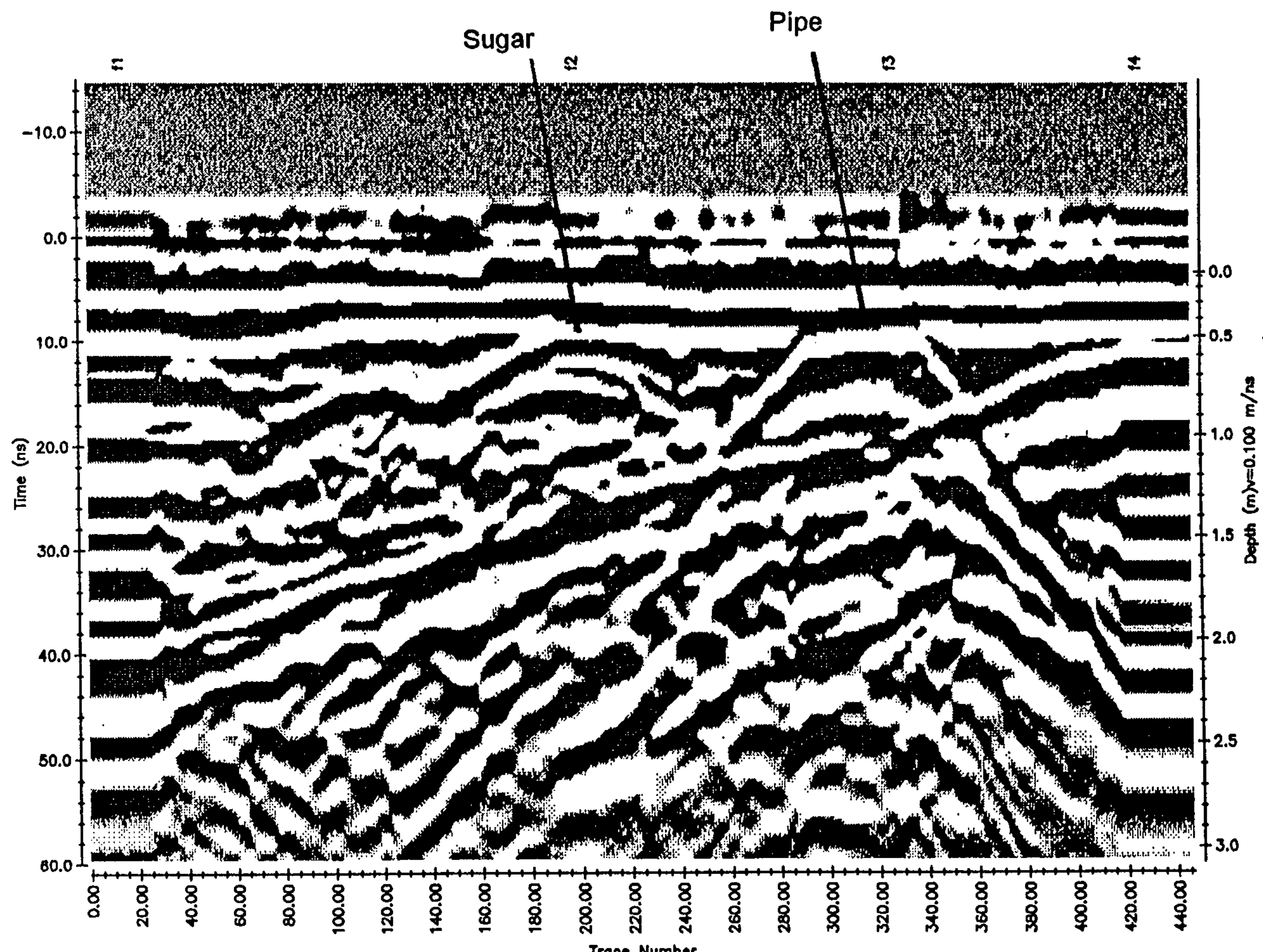
```
FILE = s:\COASTG~1\21SEP0~1\CG225BS2
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Bauxite Pile, 225 MHz, Sugar - Profile Over Sugar and Pipe
DATE = 21/09/10
NUMBER OF TRACES = 447
NUMBER OF PTS/TRC = 250
TIMEZERO AT POINT = 51
TOTAL TIME WINDOW = 75
STARTING POSITION = 0.000
FINAL POSITION = 446.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 225.00
ANTENNA SEPARATION = 0.500
PULSER VOLTAGE = 200
NUMBER OF STACKS = 4
SURVEY MODE = Reflection
COLLECTED BY PE1000 - CON: 981119 RX: 981120
                      TX: 981121 ANT: 971195/96
```

PROCESSING SELECTED

```
FILTERS:    TRACE STACKING: 2
            POINT STACKING: 2
            TRACE DIFFERENCING: N
            CORRECTION: DEWOW
SELECTION   TIME: -15 to 60
            POSITIONS: 0.000 to 446.000
GAINS:      GAIN TYPE: CONSTANT
            MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

```
TRACE SPACING AND WIDTH: 0.0250 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

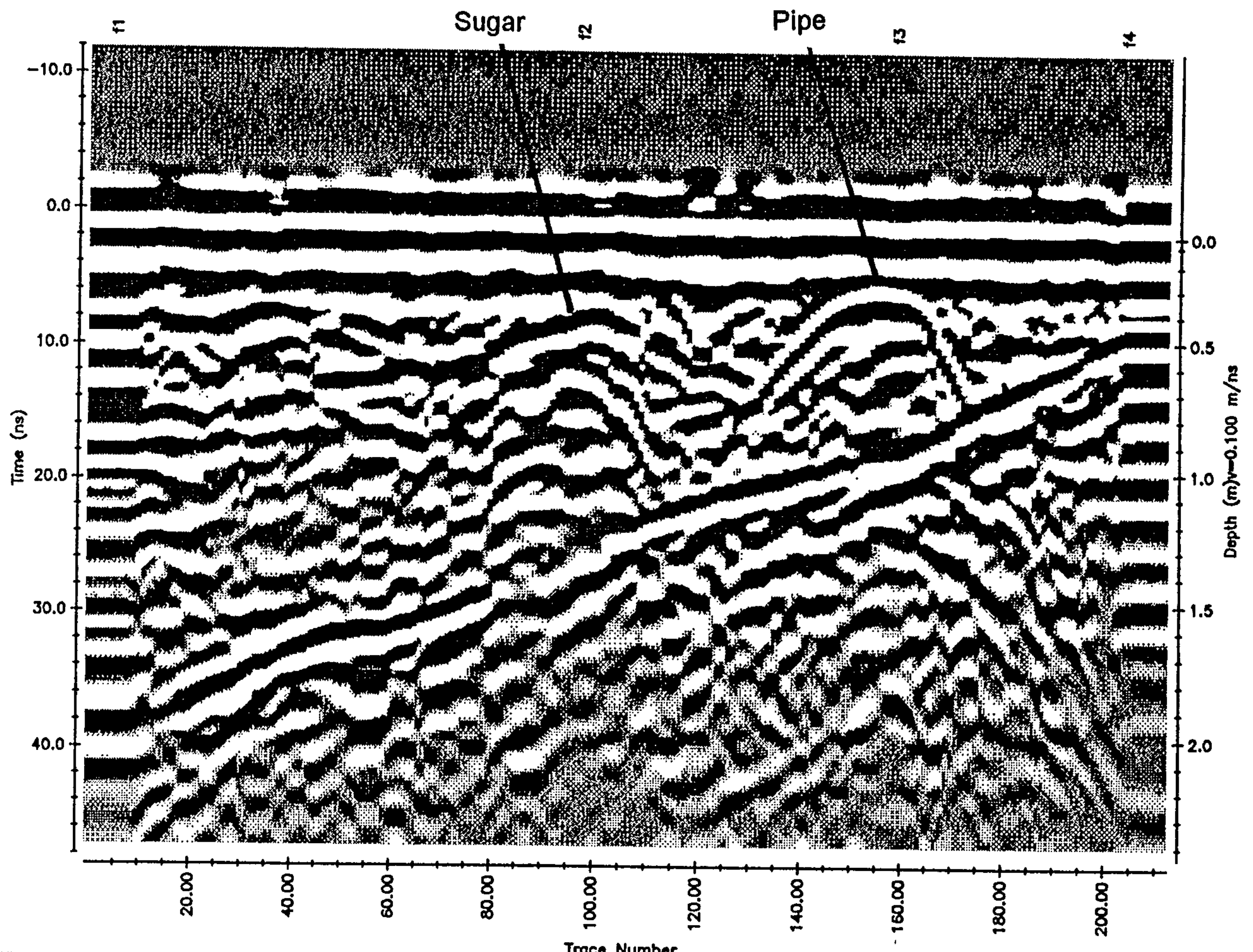
```
FILE    = s:\COASTG~1\21SEP0~1\CG450BS1
JOB#    =
TITLE   = Alabama Shipyard, Bulk Handling Area
TITLE   = Bauxite Pile, 450 MHz, Sugar - Profile Over Sugar and Pipe
DATE    = 21/09/10
NUMBER OF TRACES      = 213
NUMBER OF PTS/TRC     = 600
TIMEZERO AT POINT     = 127
TOTAL TIME WINDOW     = 60
STARTING POSITION     = 0.000
FINAL POSITION        = 212.000
STEP SIZE USED        = 1.000
POSITION UNITS        = metres
NOMINAL FREQUENCY     = 450.00
ANTENNA SEPARATION    = 0.250
PULSER VOLTAGE        = 200
NUMBER OF STACKS      = 4
SURVEY MODE           = Reflection
COLLECTED BY PE1000 - CON: 981119 RX: 981120
                      TX: 981121 ANT: 971181/82
```

PROCESSING SELECTED

```
FILTERS:    TRACE STACKING: 1
            POINT STACKING: 10
            TRACE DIFFERENCING: N
            CORRECTION: DEWOW
SELECTION   TIME: -12 to 48
            POSITIONS: 0.000 to 212.000
GAINS:      GAIN TYPE: CONSTANT
            MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

```
TRACE SPACING AND WIDTH: 0.0500 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

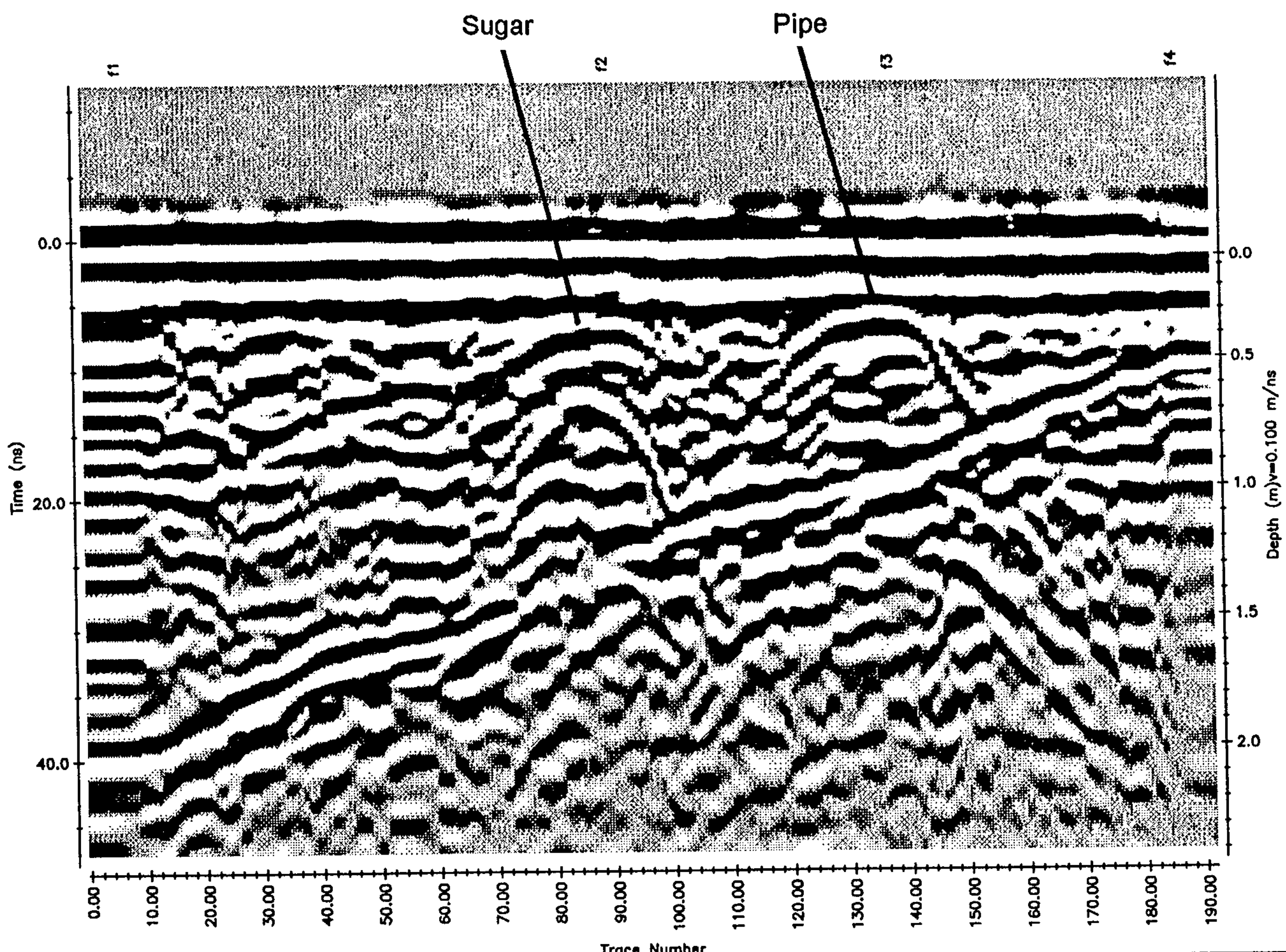
```
FILE   = s:\COASTG~1\21SEP0~1\CG450BS2
JOB#   =
TITLE  = Alabama Shipyard, Bulk Handling Area
TITLE  = Bauxite Pile, 450 MHz, Sugar - Profile Over Sugar and Pipe
DATE   = 21/09/10
NUMBER OF TRACES     = 192
NUMBER OF PTS/TRC    = 600
TIMEZERO AT POINT    = 127
TOTAL TIME WINDOW    = 60
STARTING POSITION    = 0.000
FINAL POSITION       = 191.000
STEP SIZE USED       = 1.000
POSITION UNITS       = metres
NOMINAL FREQUENCY    = 450.00
ANTENNA SEPARATION   = 0.250
PULSER VOLTAGE       = 200
NUMBER OF STACKS     = 4
SURVEY MODE          = Reflection
COLLECTED BY PE1000 - CON: 981119 RX: 981120
                      TX: 981121 ANT: 971181/82
```

PROCESSING SELECTED

```
FILTERS:    TRACE STACKING: 1
            POINT STACKING: 10
            TRACE DIFFERENCING: N
            CORRECTION: DEWOW
SELECTION   TIME: -12 to 48
            POSITIONS: 0.000 to 191.000
GAINS:      GAIN TYPE: CONSTANT
            MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

```
TRACE SPACING AND WIDTH: 0.0600 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```

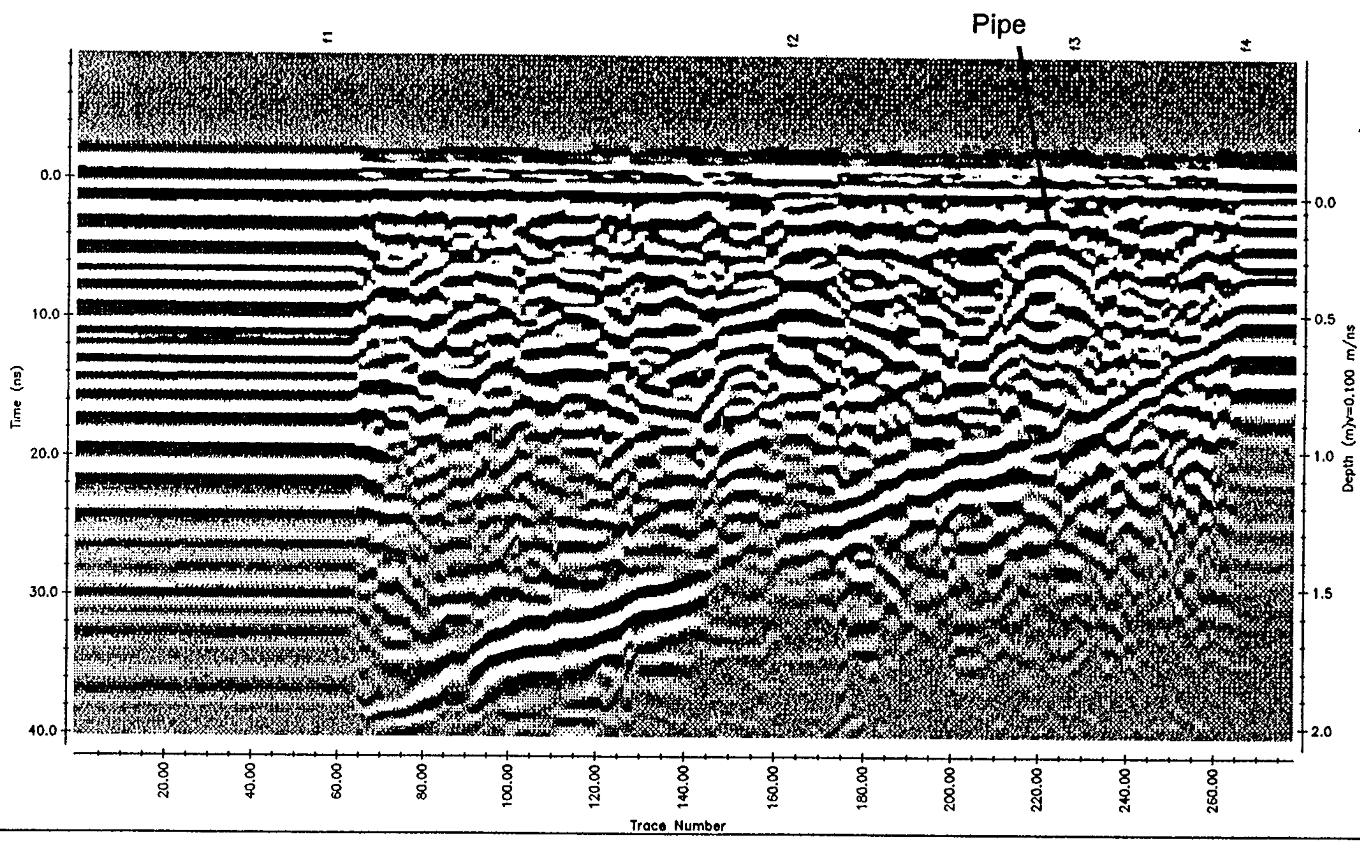


pulseEKKO HEADER PARAMETERS

FILE = s:\COASTG~1\21SEP0~1\CG900BS1
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Bauxite Pile, 900 MHz, Sugar – Profile Over Sugar and Pipe
DATE = 21/09/10
NUMBER OF TRACES = 279
NUMBER OF PTS/TRC = 500
TIMEZERO AT POINT = 98
TOTAL TIME WINDOW = 50
STARTING POSITION = 0.000
FINAL POSITION = 278.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 900.00
ANTENNA SEPARATION = 0.170
PULSER VOLTAGE = 200
NUMBER OF STACKS = 4
SURVEY MODE = Reflection
COLLECTED BY PE1000 – CON: 981119 RX: 981120
TX: 981121 ANT: 971258/59

PROCESSING SELECTED
FILTERS: TRACE STACKING: 1
POINT STACKING: 5
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: –9 to 41
POSITIONS: 0.000 to 278.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

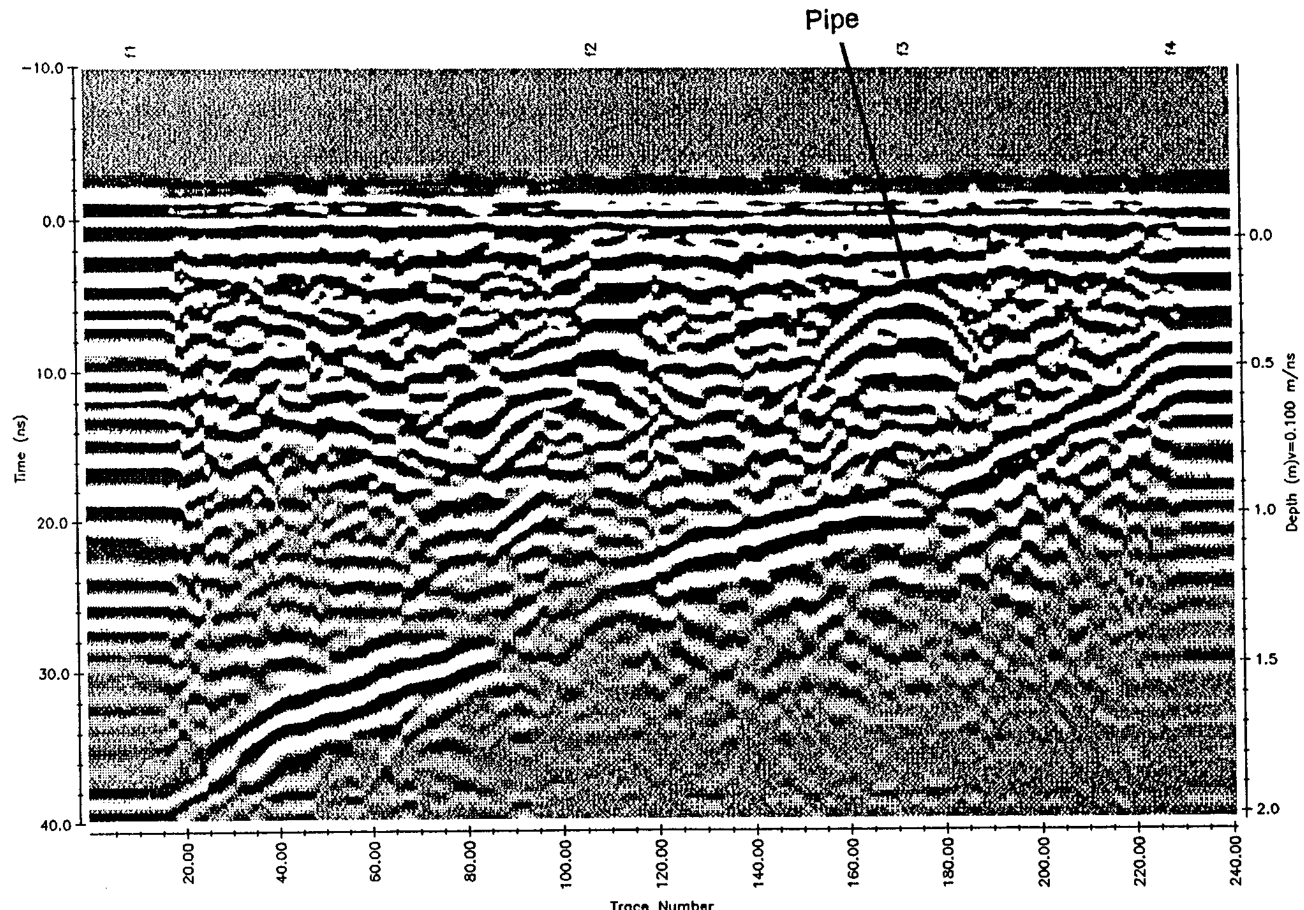
PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0500 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: –0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



```
pulseEKKO HEADER PARAMETERS
    FILE  = s:\COASTG~1\21SEP0~1\CG900BS2
    JOB# =
    TITLE = Alabama Shipyard, Bulk Handling Area
    TITLE = Bauxite Pile, 900 MHz, Sugar - Profile Over Sugar and Pipe
    DATE  = 21/09/10
    NUMBER OF TRACES      = 241
    NUMBER OF PTS/TRC     = 500
    TIMEZERO AT POINT     = 102
    TOTAL TIME WINDOW     = 50
    STARTING POSITION     = 0.000
    FINAL POSITION        = 240.000
    STEP SIZE USED        = 1.000
    POSITION UNITS        = metres
    NOMINAL FREQUENCY     = 900.00
    ANTENNA SEPARATION    = 0.170
    PULSER VOLTAGE        = 200
    NUMBER OF STACKS      = 4
    SURVEY MODE           = Reflection
    COLLECTED BY PE1000 - CON: 981119 RX: 981120
                          TX: 981121 ANT: 971258/59

PROCESSING SELECTED
   FILTERS:     TRACE STACKING: 1
                POINT STACKING: 5
                TRACE DIFFERENCING: N
                CORRECTION: DEWOW
   SELECTION    TIME: -10 to 40
                POSITIONS: 0.000 to 240.000
   GAINS:       GAIN TYPE: CONSTANT
                MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
   TRACE SPACING AND WIDTH: 0.0500 and 0.2500
   TRACE BOTTOM AND TOP: 1.0000  and 9.0000
   MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
   PAGE WIDTH: 10.0000
   BORDER SIZE: 0.000
   PRINTER NAME: LAS300
   SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

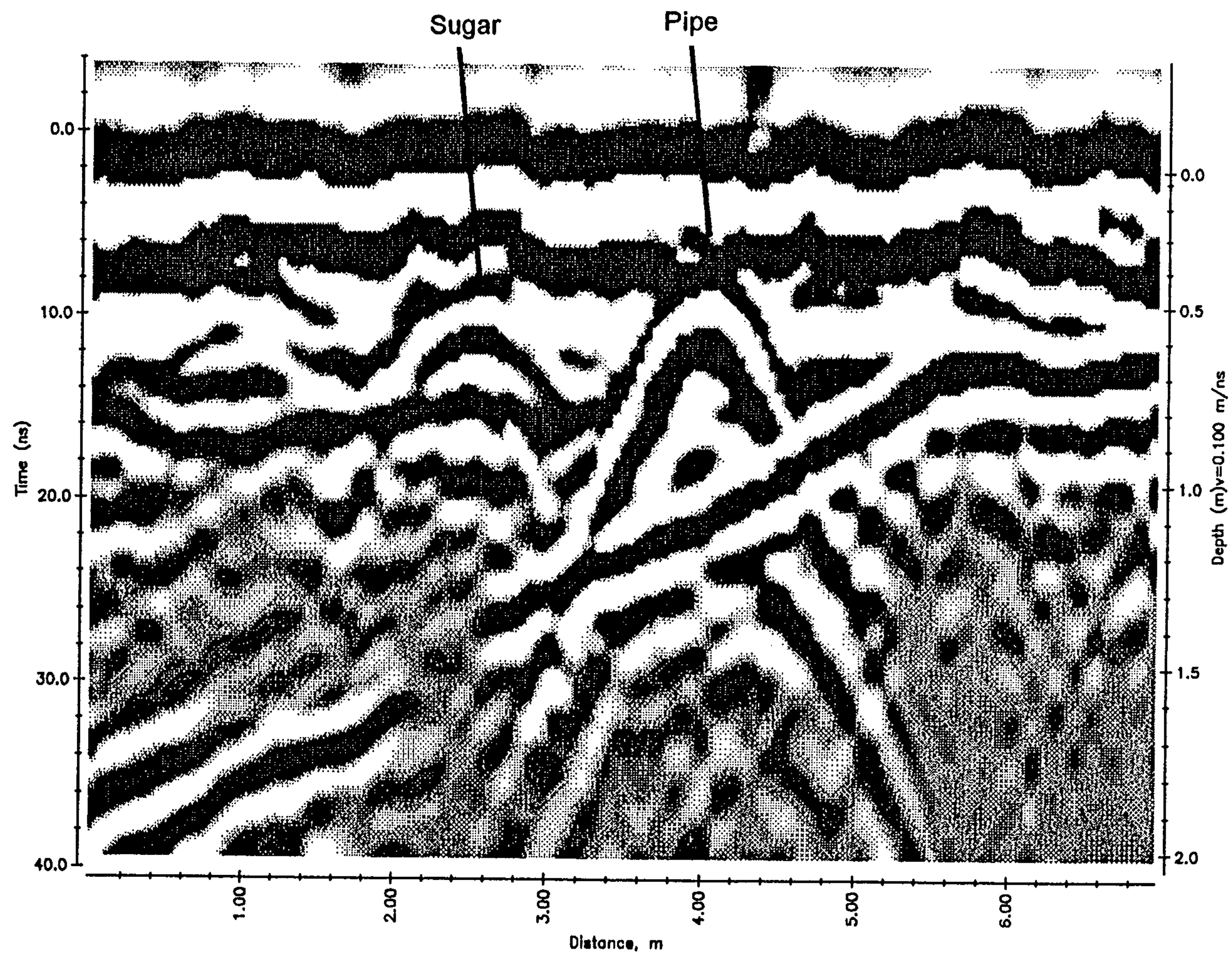
FILE = s:\COASTG~1\21SEP0~1\CG250BS0
JOB# =
TITLE = Alabama Shipyard, Bulk Handling Area
TITLE = Bauxite Pile, 250 MHz, Sugar – Profile Over Sugar and Pipe
DATE = 09/21/20
NUMBER OF TRACES = 140
NUMBER OF PTS/TRC = 111
TIMEZERO AT POINT = 11
TOTAL TIME WINDOW = 44
STARTING POSITION = 0.000
FINAL POSITION = 6.950
STEP SIZE USED = 0.050
POSITION UNITS = m
NOMINAL FREQUENCY = 250.00
ANTENNA SEPARATION = 0.305
PULSER VOLTAGE = 100
NUMBER OF STACKS = 16
SURVEY MODE = Reflection

PROCESSING SELECTED

FILTERS: TRACE STACKING: 1
POINT STACKING: 5
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: –4 to 40
POSITIONS: 0.000 to 6.950
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS

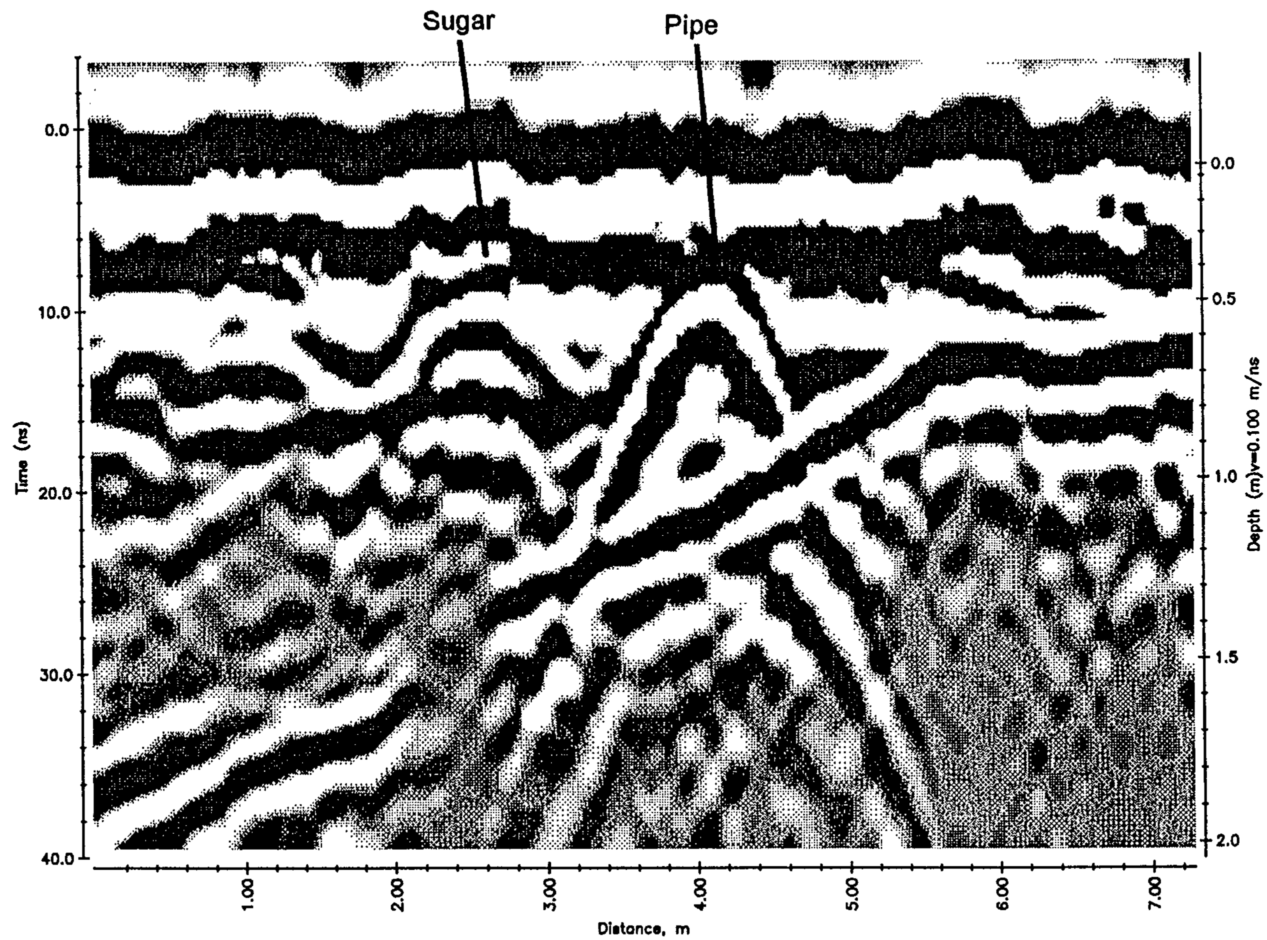
TRACE SPACING AND WIDTH: 0.0750 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: –0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



```
pulseEKKO HEADER PARAMETERS
     FILE  = s:\COASTG~1\21SEP0~1\CG250BS1
     JOB#  =
     TITLE = Alabama Shipyard, Bulk Handling Area
     TITLE = Bauxite Pile, 250 MHz, Sugar - Profile Over Sugar and Pipe
     DATE  = 09/21/20
     NUMBER OF TRACES      = 146
     NUMBER OF PTS/TRC     = 111
     TIMEZERO AT POINT     = 11
     TOTAL TIME WINDOW     = 44
     STARTING POSITION     = 0.000
     FINAL POSITION        = 7.250
     STEP SIZE USED        = 0.050
     POSITION UNITS        = m
     NOMINAL FREQUENCY     = 250.00
     ANTENNA SEPARATION    = 0.305
     PULSER VOLTAGE        = 100
     NUMBER OF STACKS      = 16
     SURVEY MODE           = Reflection

PROCESSING SELECTED
     FILTERS:    TRACE STACKING: 1
                 POINT STACKING: 5
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
     SELECTION   TIME: -4 to 40
                 POSITIONS: 0.000 to 7.250
     GAINS:      GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0750 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```

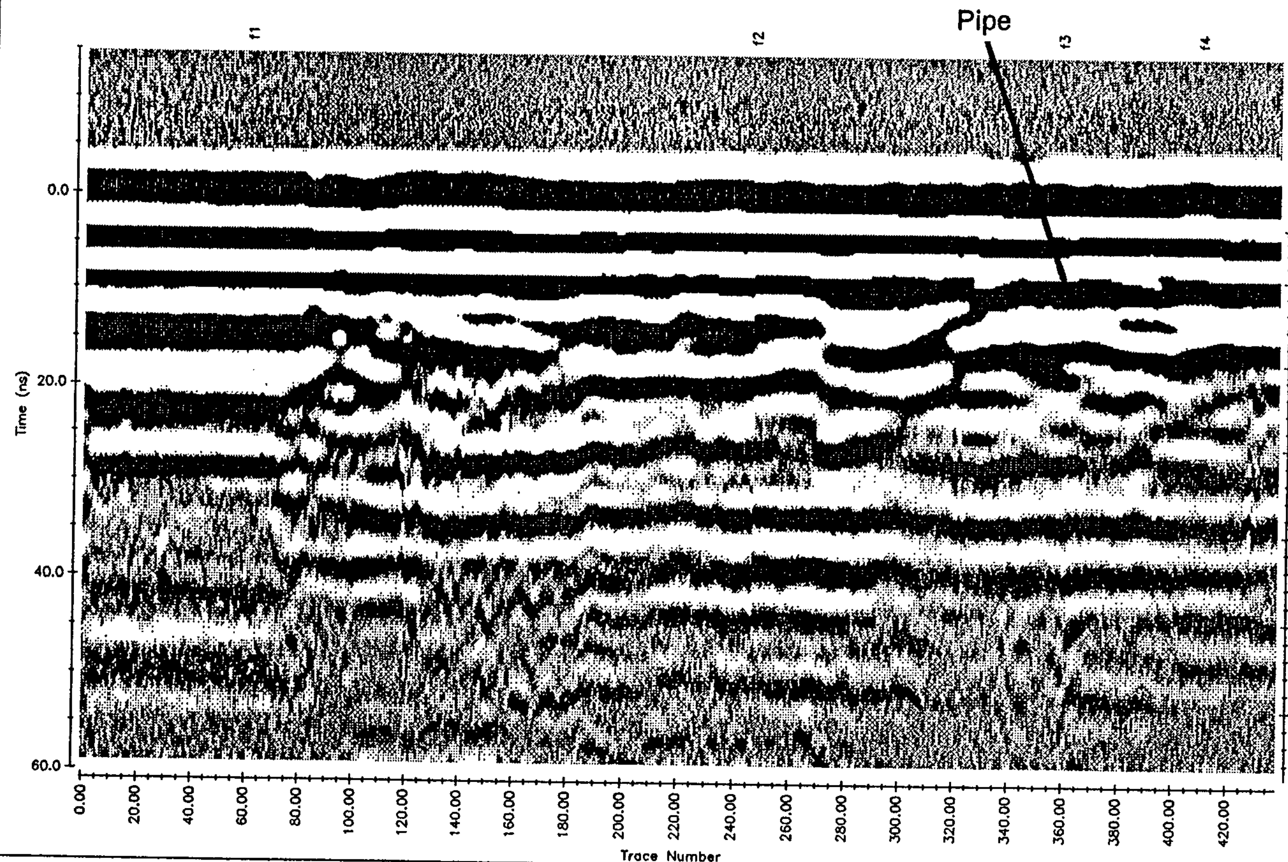


Appendix I
Coal
GPR Records – Buried Contraband Simulant Test

pulseEKKO HEADER PARAMETERS
FILE = s:\COASTG~1\21SEP0~1\CG225LS1
JOB# =
TITLE = U.S. Coast Guard
TITLE = Coal Pile (second), 225 MHz, Sugar
DATE = 21/09/10
NUMBER OF TRACES = 439
NUMBER OF PTS/TRC = 250
TIMEZERO AT POINT = 53
TOTAL TIME WINDOW = 75
STARTING POSITION = 0.000
FINAL POSITION = 438.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 225.00
ANTENNA SEPARATION = 0.500
PULSER VOLTAGE = 200
NUMBER OF STACKS = 4
SURVEY MODE = Reflection
COLLECTED BY PE1000 – CON: 981119 RX: 981120
TX: 981121 ANT: 971195/96

PROCESSING SELECTED
FILTERS: TRACE STACKING: 1
POINT STACKING: 5
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: –15 to 60
POSITIONS: 0.000 to 438.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

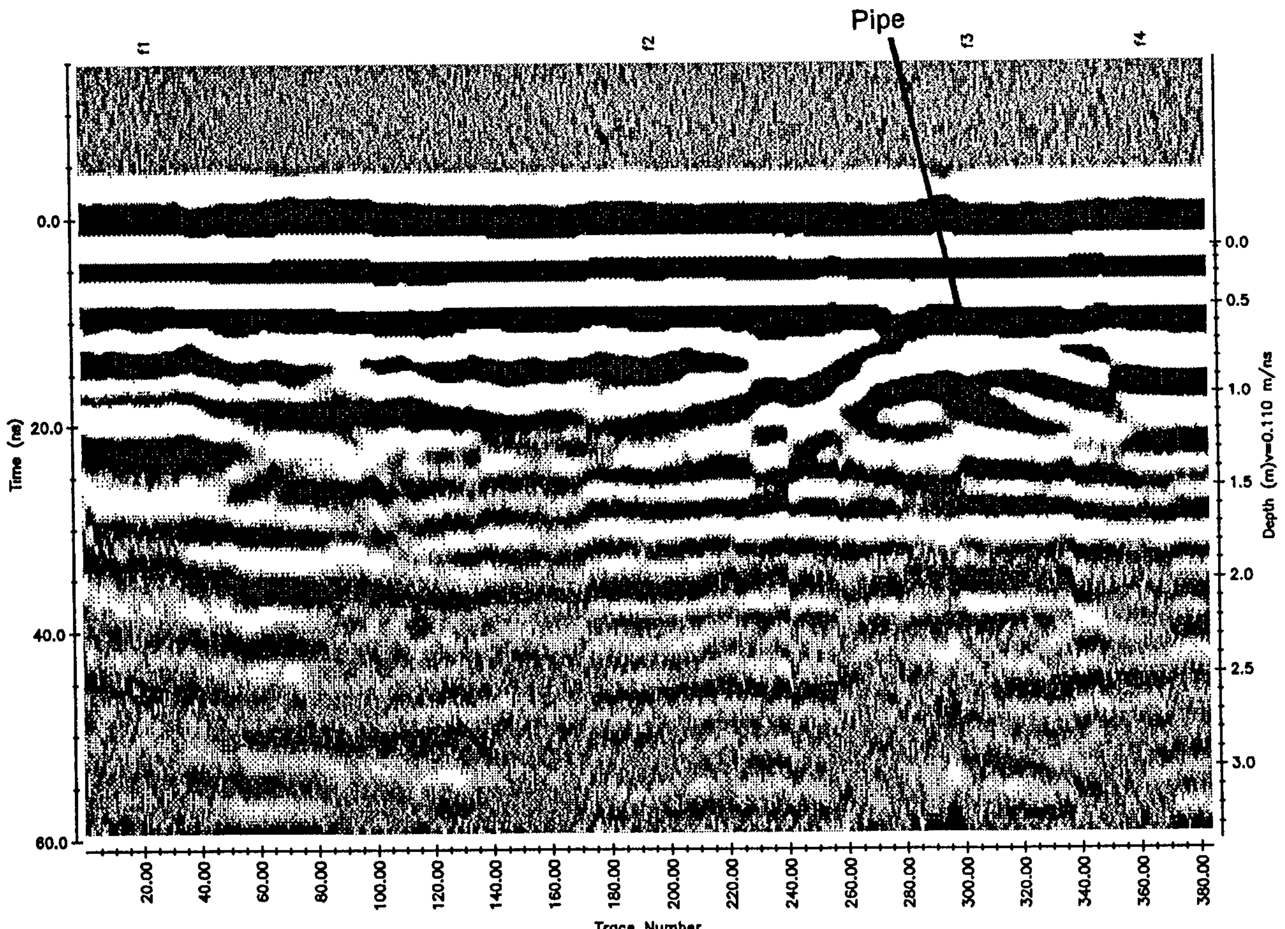
PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0300 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: –0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



```
pulseEKKO HEADER PARAMETERS
    FILE   = s:\COASTG~1\21SEP0~1\CG225LS2
    JOB#   =
    TITLE  = U.S. Coast Guard
    TITLE  = Coal Pile (second), 225 MHz, Sugar
    DATE   = 21/09/10
    NUMBER OF TRACES      = 384
    NUMBER OF PTS/TRC     = 250
    TIMEZERO AT POINT     = 52
    TOTAL TIME WINDOW     = 75
    STARTING POSITION     = 0.000
    FINAL POSITION        = 383.000
    STEP SIZE USED        = 1.000
    POSITION UNITS        = metres
    NOMINAL FREQUENCY     = 225.00
    ANTENNA SEPARATION    = 0.500
    PULSER VOLTAGE        = 200
    NUMBER OF STACKS      = 4
    SURVEY MODE           = Reflection
    COLLECTED BY PE1000 - CON: 981119 RX: 981120
                          TX: 981121 ANT: 971195/96

PROCESSING SELECTED
    FILTERS:    TRACE STACKING: 1
                POINT STACKING: 5
                TRACE DIFFERENCING: N
                CORRECTION: DEWOW
    SELECTION   TIME: -15 to 60
                POSITIONS: 0.000 to 383.000
    GAINS:      GAIN TYPE: CONSTANT
                MULTIPLIER: 100.000

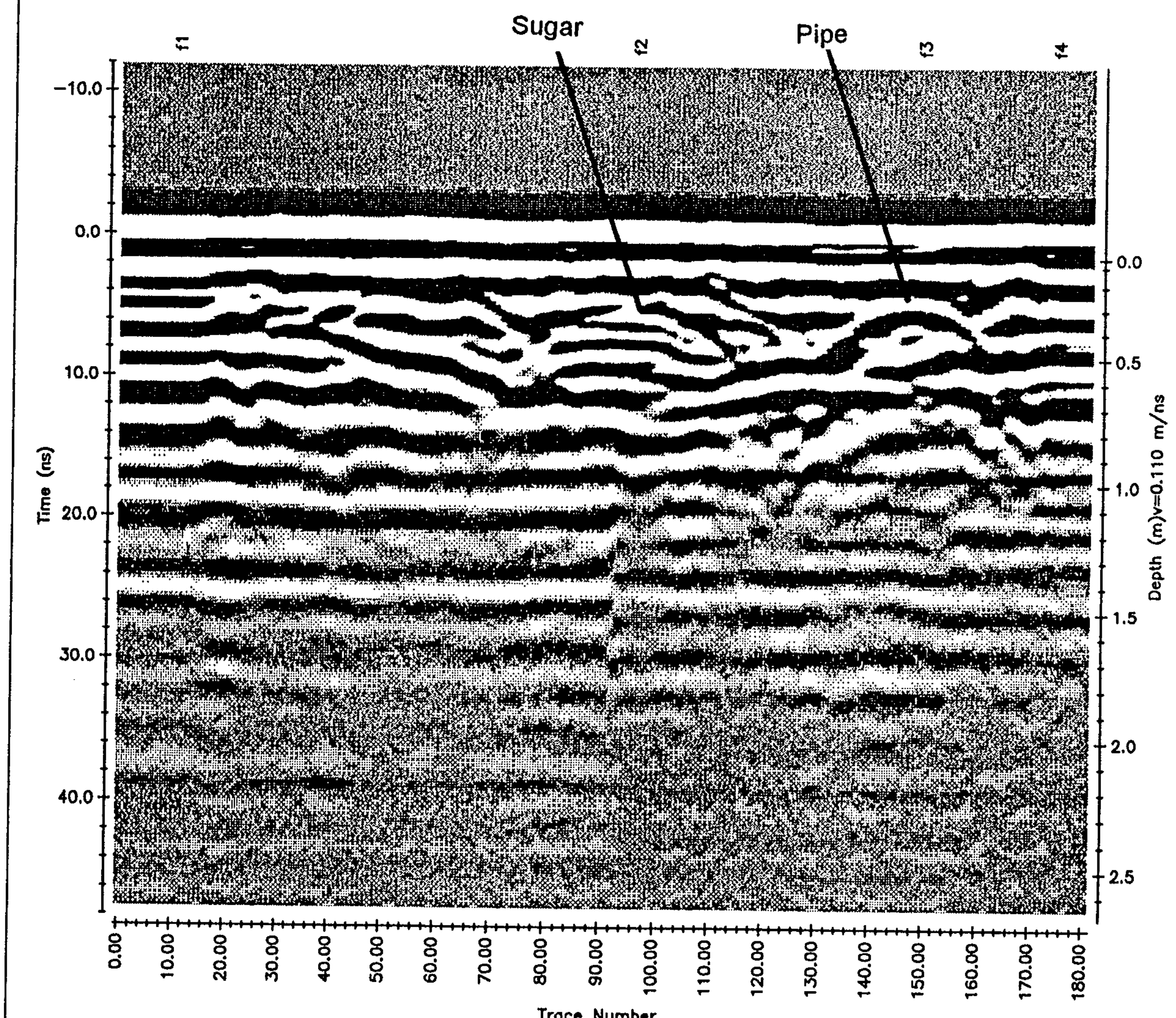
PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.0300 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000 and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



```
pulseEKKO HEADER PARAMETERS
     FILE  = s:\COASTG~1\21SEP0~1\CG450LS1
     JOB#  =
     TITLE = U.S. Coast Guard
     TITLE = Coal Pile (second), 450 MHz, Sugar
     DATE  = 21/09/10
     NUMBER OF TRACES    = 182
     NUMBER OF PTS/TRC   = 600
     TIMEZERO AT POINT   = 126
     TOTAL TIME WINDOW   = 60
     STARTING POSITION   = 0.000
     FINAL POSITION      = 181.000
     STEP SIZE USED      = 1.000
     POSITION UNITS      = metres
     NOMINAL FREQUENCY   = 450.00
     ANTENNA SEPARATION  = 0.250
     PULSER VOLTAGE      = 200
     NUMBER OF STACKS    = 4
     SURVEY MODE         = Reflection
     COLLECTED BY PE1000 - CON: 981119 RX: 981120
                           TX: 981121 ANT: 971181/82

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 1
                  POINT STACKING: 5
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -12 to 48
                  POSITIONS: 0.000 to 181.000
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0500 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
     MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
     PAGE WIDTH: 10.0000
     BORDER SIZE: 0.000
     PRINTER NAME: LAS300
     SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS

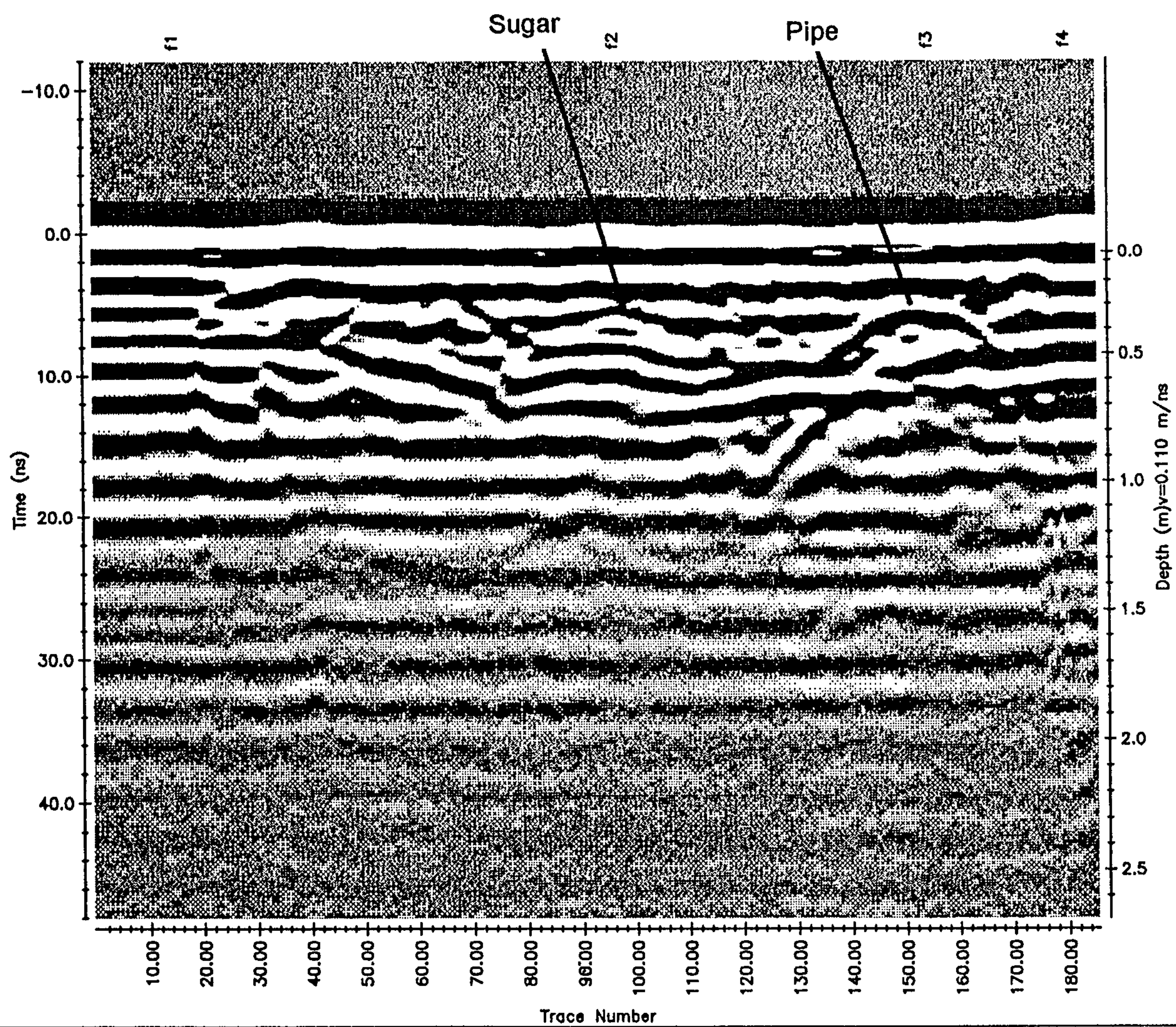
```
    FILE  = s:\COASTG~1\21SEP0~1\CG450LS2
    JOB#  =
    TITLE = U.S. Coast Guard
    TITLE = Coal Pile (second), 450 MHz, Sugar
    DATE  = 21/09/10
    NUMBER OF TRACES     = 186
    NUMBER OF PTS/TRC    = 600
    TIMEZERO AT POINT    = 120
    TOTAL TIME WINDOW    = 60
    STARTING POSITION    = 0.000
    FINAL POSITION       = 185.000
    STEP SIZE USED       = 1.000
    POSITION UNITS       = metres
    NOMINAL FREQUENCY    = 450.00
    ANTENNA SEPARATION   = 0.250
    PULSER VOLTAGE       = 200
    NUMBER OF STACKS     = 4
    SURVEY MODE          = Reflection
    COLLECTED BY PE1000 - CON: 981119 RX: 981120
                          TX: 981121 ANT: 971181/82
```

PROCESSING SELECTED

```
    FILTERS:    TRACE STACKING: 1
                POINT STACKING: 5
                TRACE DIFFERENCING: N
                CORRECTION: DEWOW
    SELECTION   TIME: -12 to 48
                POSITIONS: 0.000 to 185.000
    GAINS:      GAIN TYPE: CONSTANT
                MULTIPLIER: 100.000
```

PLOT LAYOUT PARAMETERS

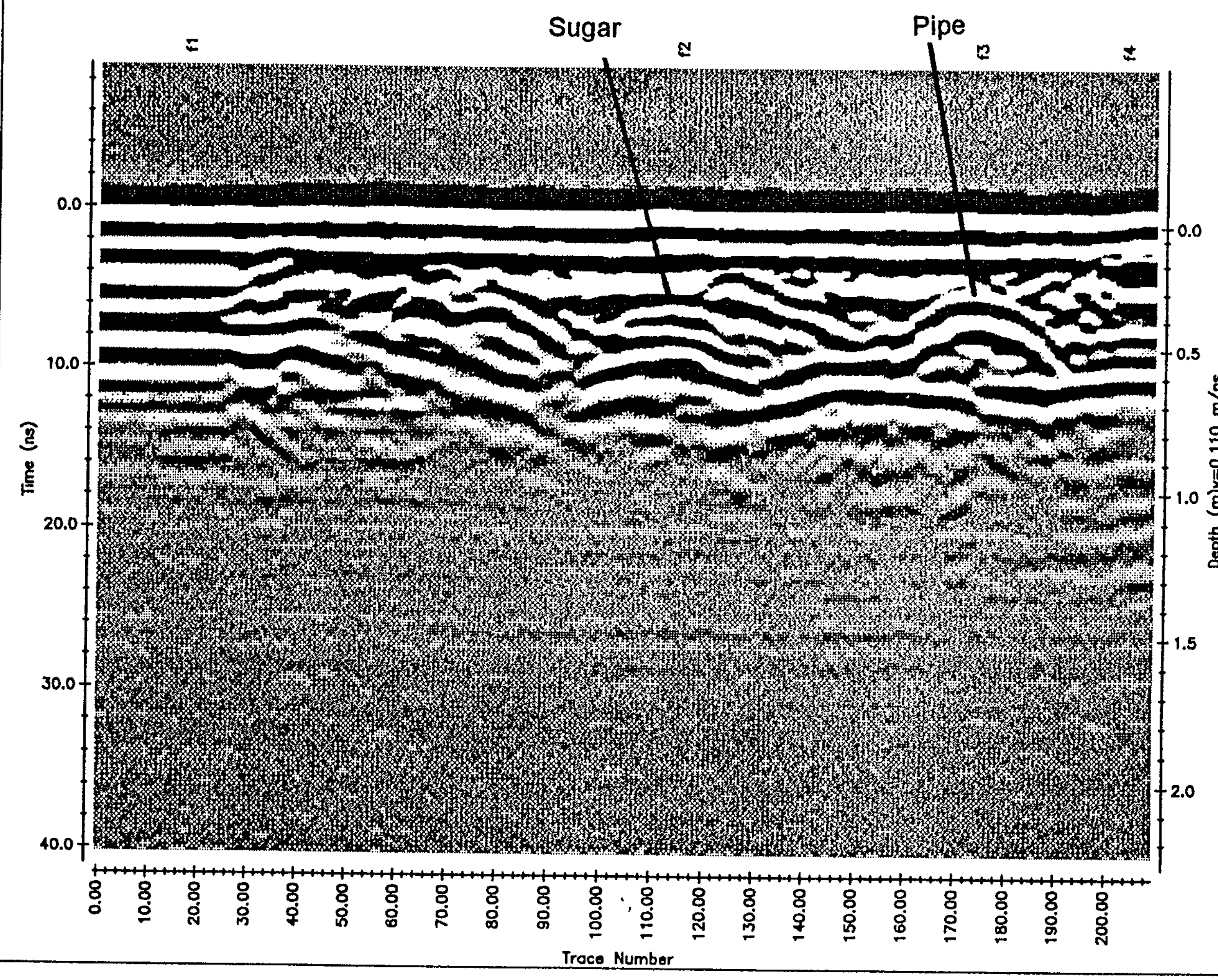
```
    TRACE SPACING AND WIDTH: 0.0500 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
    PAGE WIDTH: 10.0000
    BORDER SIZE: 0.000
    PRINTER NAME: LAS300
    SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0
```



pulseEKKO HEADER PARAMETERS
FILE = s:\COASTG~1\21SEP0~1\CG900LS1
JOB# =
TITLE = U.S. Coast Guard
TITLE = Coal Pile (second), 900 MHz, Sugar
DATE = 21/09/10
NUMBER OF TRACES = 210
NUMBER OF PTS/TRC = 500
TIMEZERO AT POINT = 97
TOTAL TIME WINDOW = 50
STARTING POSITION = 0.000
FINAL POSITION = 209.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 900.00
ANTENNA SEPARATION = 0.170
PULSER VOLTAGE = 200
NUMBER OF STACKS = 4
SURVEY MODE = Reflection
COLLECTED BY PE1000 – CON: 981119 RX: 981120
TX: 981121 ANT: 971258/59

PROCESSING SELECTED
FILTERS: TRACE STACKING: 1
POINT STACKING: 5
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: –9 to 41
POSITIONS: 0.000 to 209.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

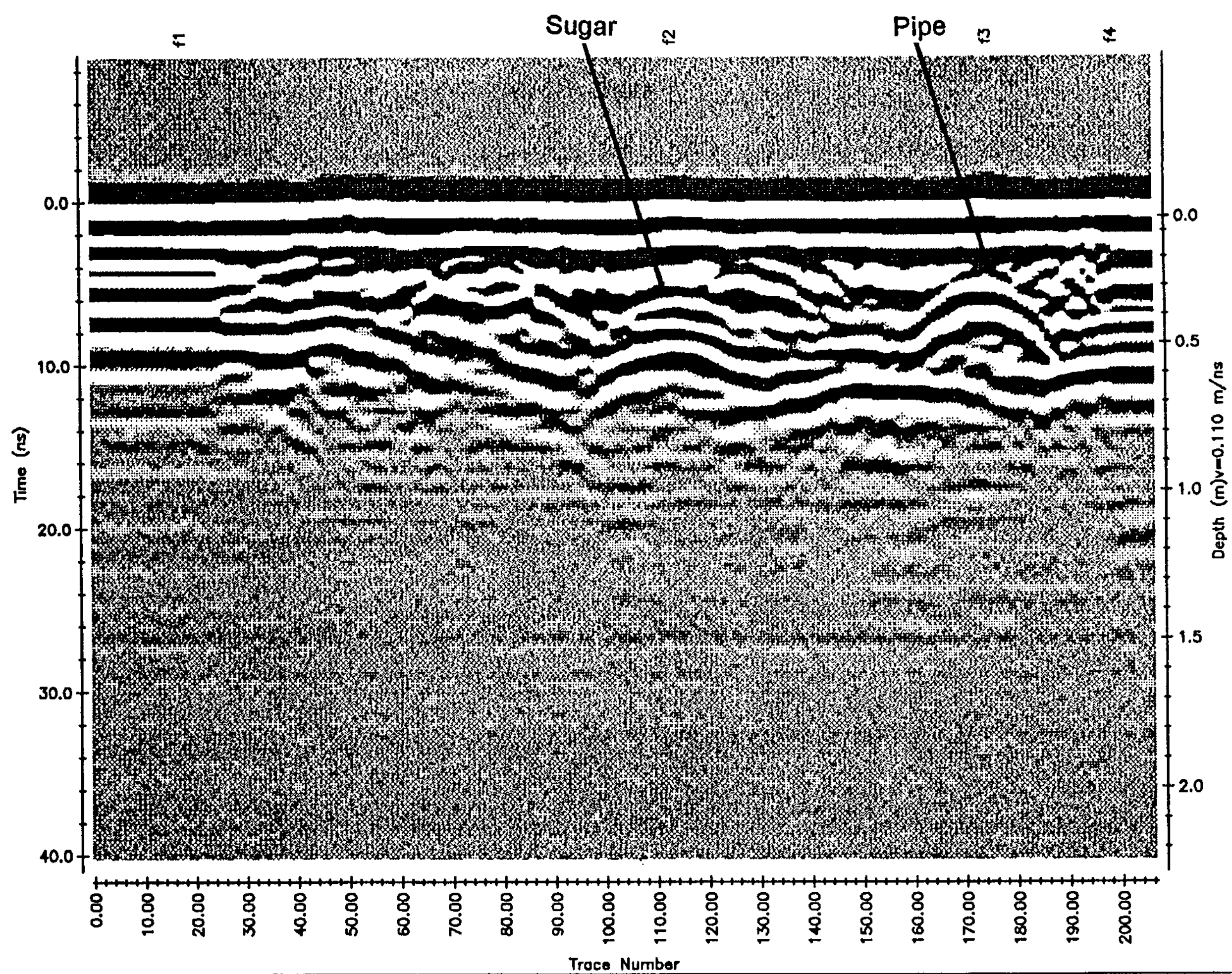
PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0500 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: –0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



pulseEKKO HEADER PARAMETERS
FILE = s:\COASTG~1\21SEP0~1\CG900LS2
JOB# =
TITLE = U.S. Coast Guard
TITLE = Coal Pile (second), 900 MHz, Sugar
DATE = 21/09/10
NUMBER OF TRACES = 207
NUMBER OF PTS/TRC = 500
TIMEZERO AT POINT = 97
TOTAL TIME WINDOW = 50
STARTING POSITION = 0.000
FINAL POSITION = 206.000
STEP SIZE USED = 1.000
POSITION UNITS = metres
NOMINAL FREQUENCY = 900.00
ANTENNA SEPARATION = 0.170
PULSER VOLTAGE = 200
NUMBER OF STACKS = 4
SURVEY MODE = Reflection
COLLECTED BY PE1000 – CON: 981119 RX: 981120
TX: 981121 ANT: 971258/59

PROCESSING SELECTED
FILTERS: TRACE STACKING: 1
POINT STACKING: 5
TRACE DIFFERENCING: N
CORRECTION: DEWOW
SELECTION TIME: –9 to 41
POSITIONS: 0.000 to 206.000
GAINS: GAIN TYPE: CONSTANT
MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
TRACE SPACING AND WIDTH: 0.0500 and 0.2500
TRACE BOTTOM AND TOP: 1.0000 and 9.0000
MARGIN LEFT AND RIGHT: –0.5000 and 1.0000
PAGE WIDTH: 10.0000
BORDER SIZE: 0.000
PRINTER NAME: LAS300
SCALE BAR: Name:GREY Type:EA Expansion:0.500 Contour:0



```
pulseEKKO HEADER PARAMETERS
     FILE   = s:\COASTG~1\21SEP0~1\CG250LS0
     JOB#   = 1234
     TITLE  = Data Collected with Noggin Plus
     TITLE  =
     DATE   = 09/21/20
     NUMBER OF TRACES       = 89
     NUMBER OF PTS/TRC      = 111
     TIMEZERO AT POINT      = 11
     TOTAL TIME WINDOW      = 44
     STARTING POSITION      = 0.000
     FINAL POSITION         = 4.400
     STEP SIZE USED         = 0.050
     POSITION UNITS         = m
     NOMINAL FREQUENCY      = 250.00
     ANTENNA SEPARATION     = 0.305
     PULSER VOLTAGE         = 100
     NUMBER OF STACKS       = 16
     SURVEY MODE            = Reflection

PROCESSING SELECTED
     FILTERS:     TRACE STACKING: 1
                  POINT STACKING: 5
                  TRACE DIFFERENCING: N
                  CORRECTION: DEWOW
     SELECTION    TIME: -4 to 40
                  POSITIONS: 0.000 to 4.400
     GAINS:       GAIN TYPE: CONSTANT
                  MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
     TRACE SPACING AND WIDTH: 0.0600 and 0.2500
     TRACE BOTTOM AND TOP: 1.0000  and 9.0000
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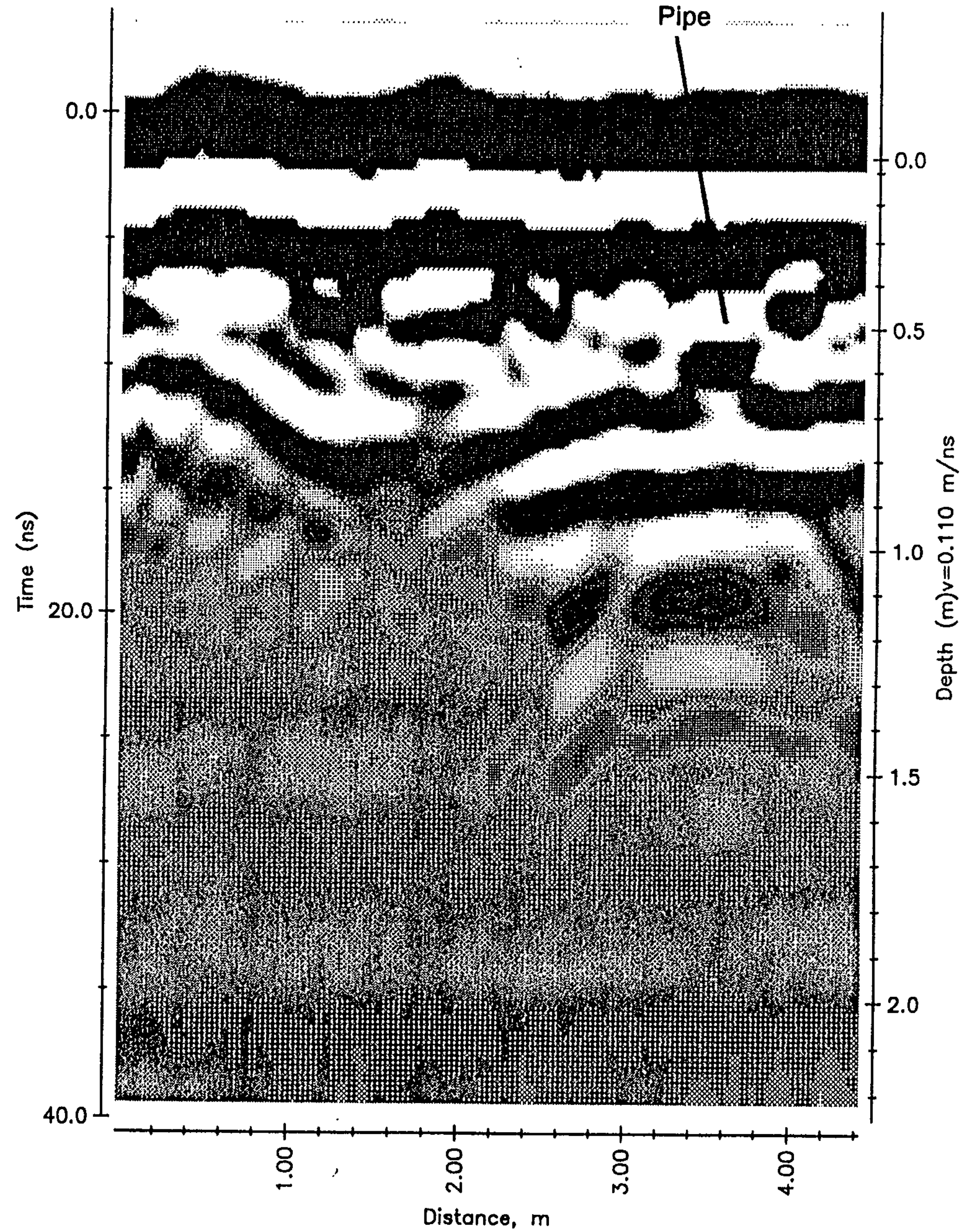

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pulseEKKO HEADER PARAMETERS
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    JOB#  = 1234
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    TITLE =
    DATE  = 09/21/20
    NUMBER OF TRACES     = 94
    NUMBER OF PTS/TRC    = 111
    TIMEZERO AT POINT    = 11
    TOTAL TIME WINDOW    = 44
    STARTING POSITION    = 0.000
    FINAL POSITION       = 4.650
    STEP SIZE USED       = 0.050
    POSITION UNITS       = m
    NOMINAL FREQUENCY    = 250.00
    ANTENNA SEPARATION   = 0.305
    PULSER VOLTAGE       = 100
    NUMBER OF STACKS     = 16
    SURVEY MODE          = Reflection

PROCESSING SELECTED
    FILTERS:     TRACE STACKING: 1
                 POINT STACKING: 5
                 TRACE DIFFERENCING: N
                 CORRECTION: DEWOW
    SELECTION    TIME: -4 to 40
                 POSITIONS: 0.000 to 4.650
    GAINS:       GAIN TYPE: CONSTANT
                 MULTIPLIER: 100.000

PLOT LAYOUT PARAMETERS
    TRACE SPACING AND WIDTH: 0.0600 and 0.2500
    TRACE BOTTOM AND TOP: 1.0000  and 9.0000
    MARGIN LEFT AND RIGHT: -0.5000 and 1.0000
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    BORDER SIZE: 0.000
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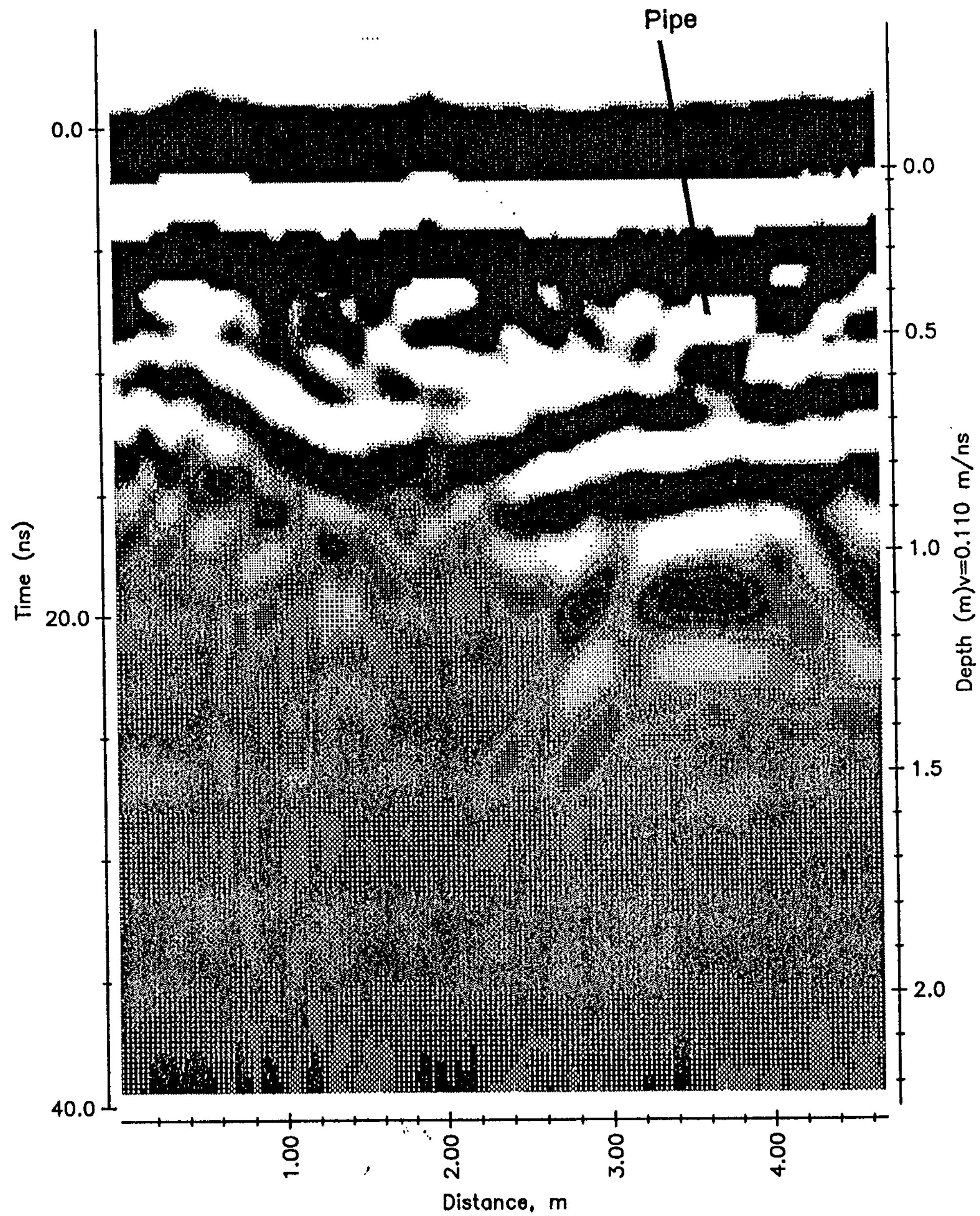

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14. ABSTRACT
Ground Penetrating Radar (GPR) surveys were conducted over various stockpiled materials at the Alabama State Docks located in Mobile, AL, to determine whether GPR is a viable method for rapidly detecting contraband materials buried in the cargo holds of ocean going vessels. The surveys were conducted by burying various objects including a contraband simulant (a bundle of four 10-lb bags of sugar duct-taped together) in stockpiled materials available at the site. The stockpiled materials tested were crystal gypsum, powdered gypsum, crushed pumice, coarse coal, fine coal, and bauxite.

Two GPR systems, the pulseEKKO 1000 and the Noggin Plus systems, manufactured by Sensors & Software, Inc., were used to conduct the surveys. GPR surveys were run over the stockpiled materials using a suite of antenna frequencies ranging between 225 and 900 MHz to determine the effects of material type on depth of penetration and target resolution.

All of the antennas tested were successful in detecting the location of the contraband simulant in at least one of the stockpiled materials. The 225 and 250 MHz antennas had the highest percentage of detecting the simulant in the stockpiled materials (60 and 90 percent, respectively) whereas the 900 MHz antenna had the lowest (30 percent). All antennas tested have penetration depths of greater than 1.5 m.

The GPR surveys run on the different stockpiled materials at the Alabama State Docks demonstrate that GPR is a feasible means of locating contraband buried to depths of at least 1 to 2 m (limit of testing). However, the probability of success of locating contraband with GPR on board ships depends on the size and depth of the target as well as the magnetic and electrical properties of the target and the material in which it is hidden.

15. SUBJECT TERMS
Conductivity, Contraband, Detection, Geophysics, Ground Penetrating Radar (GPR)

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